



201020 5549901

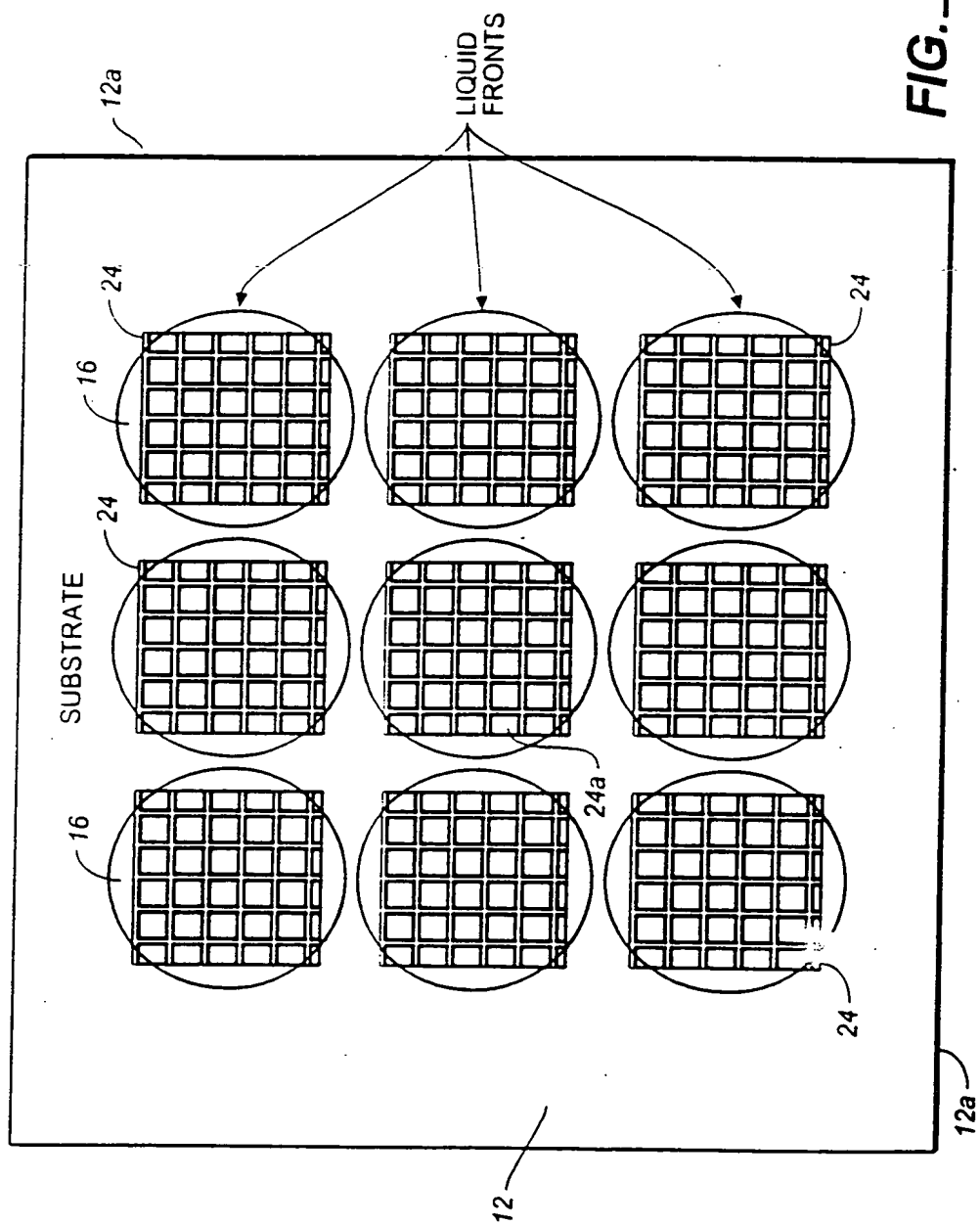
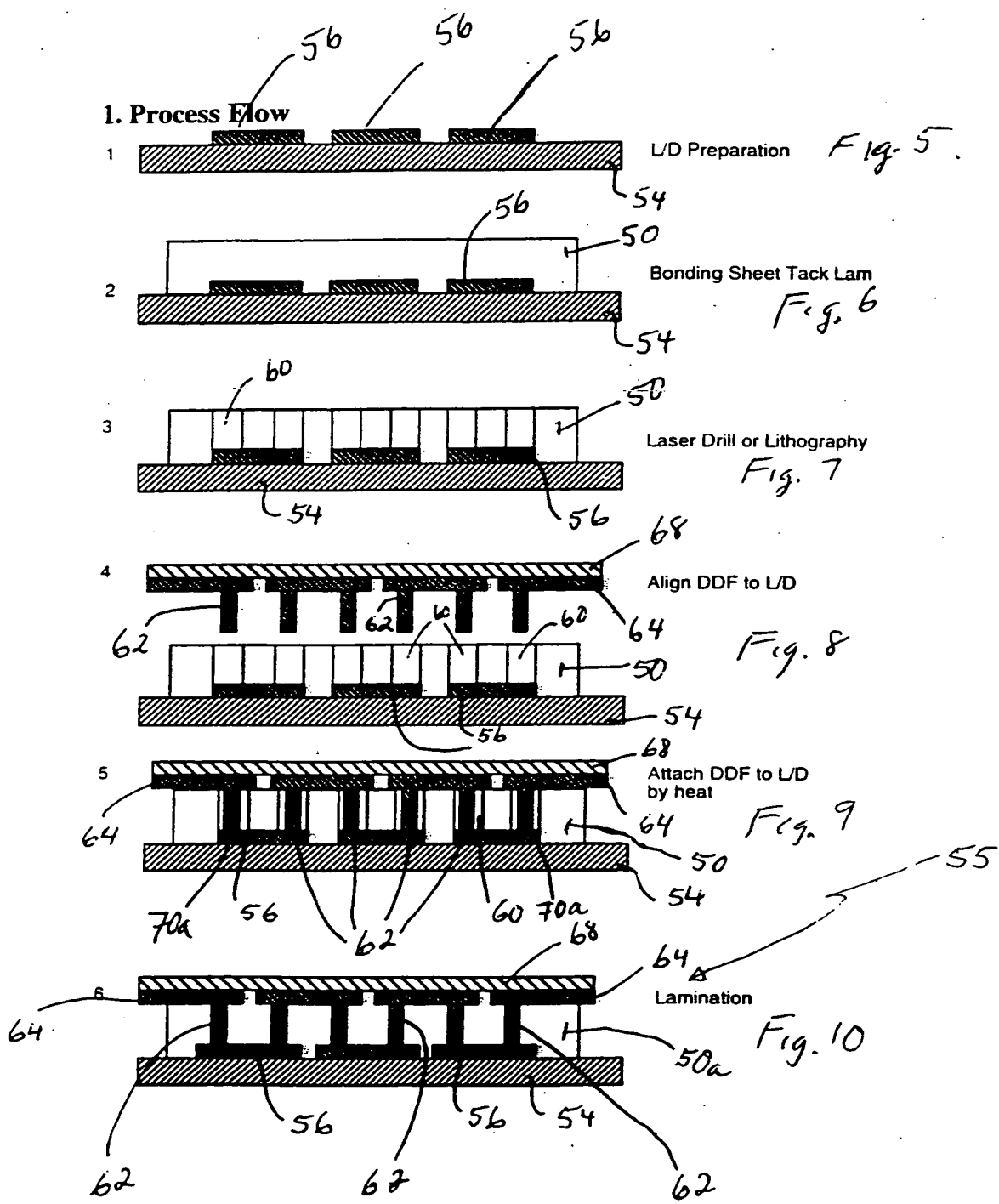
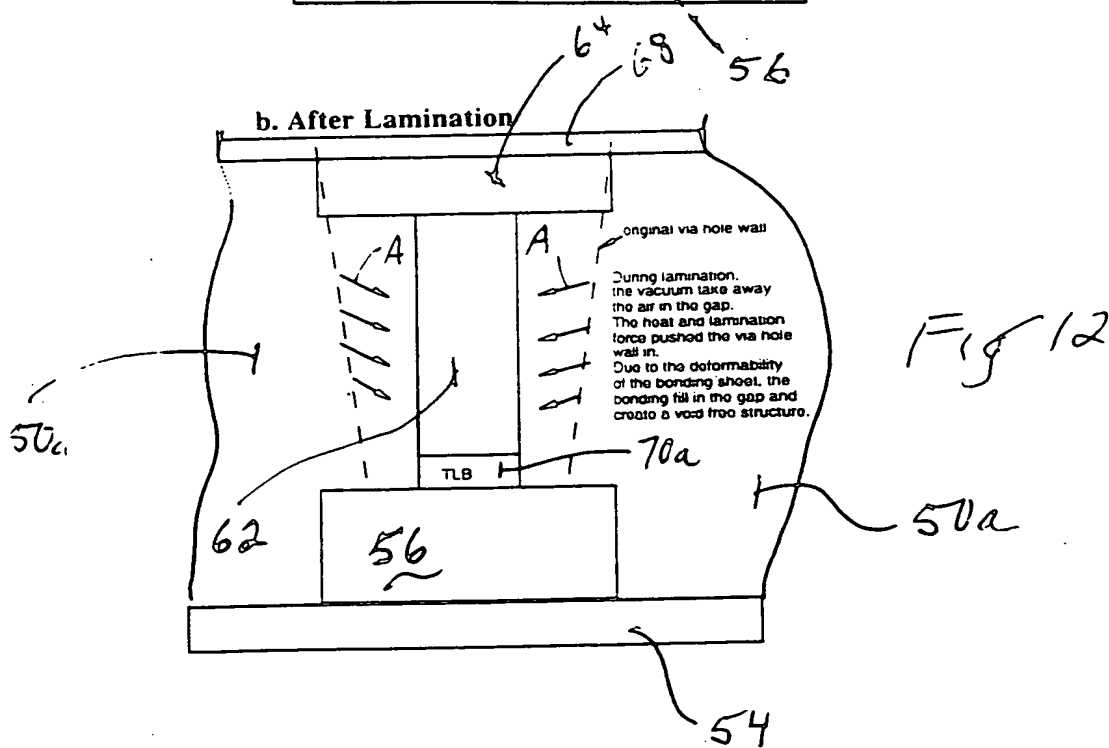
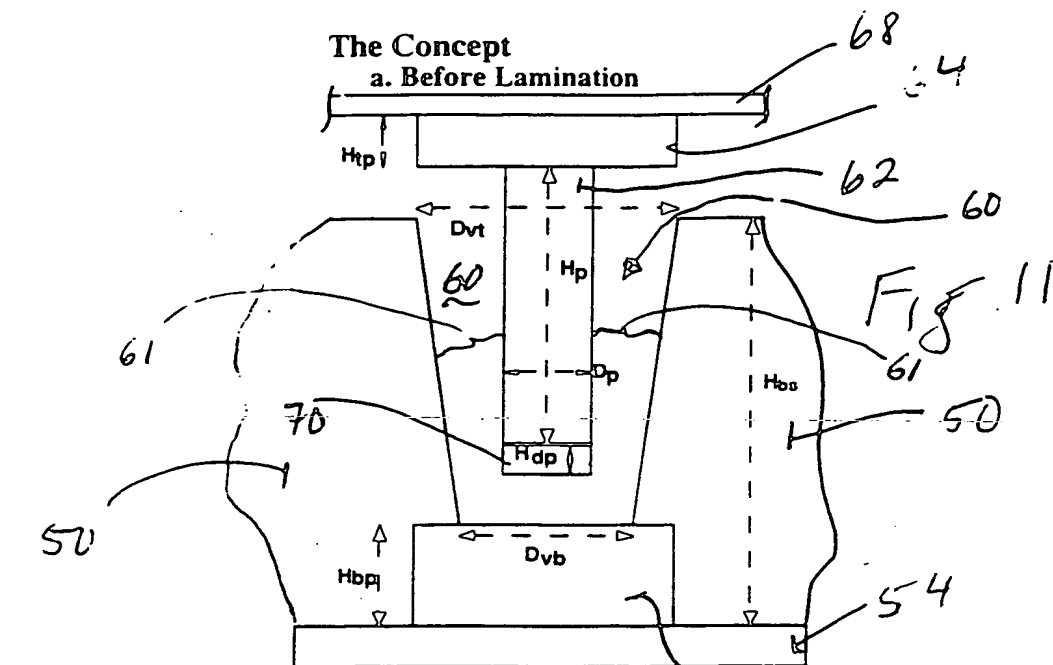


FIG. 4

207020 5835301



10065495 020102



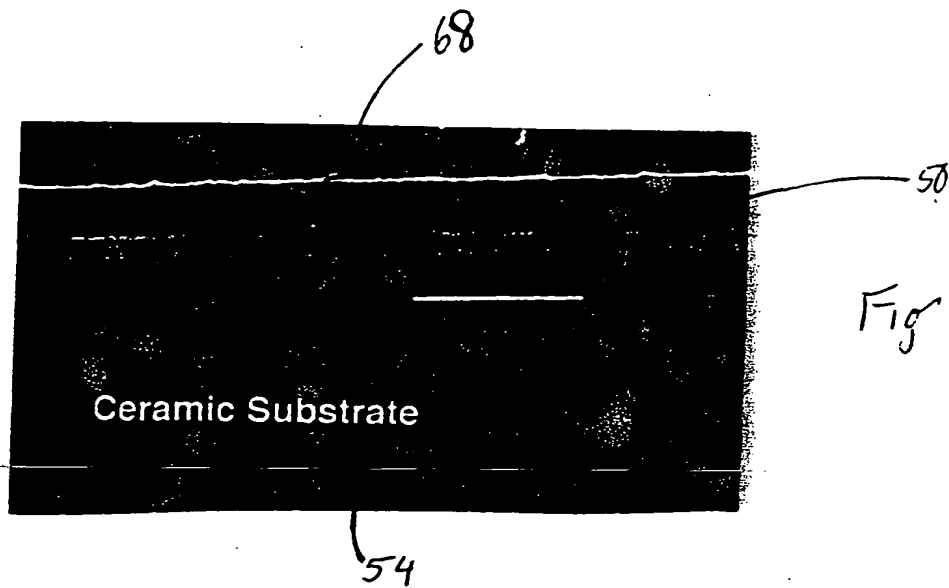


Fig 13

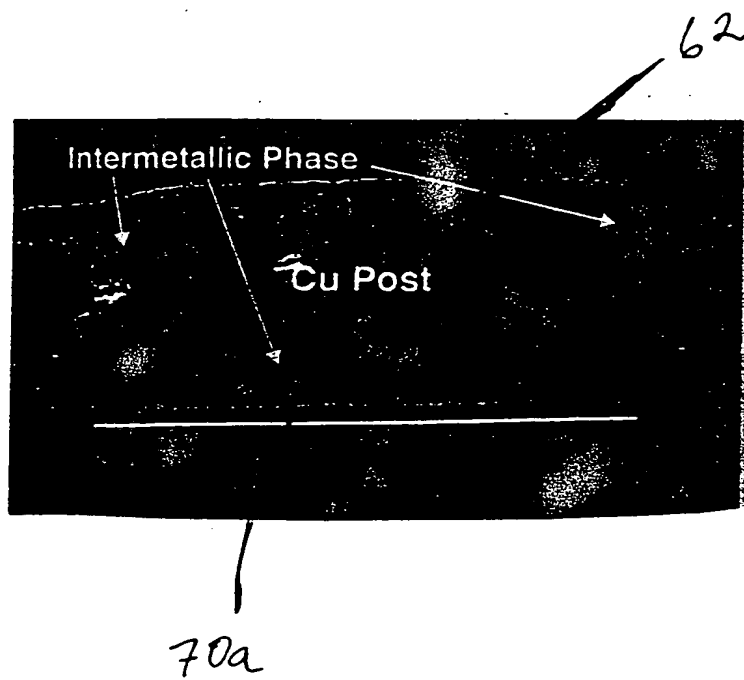
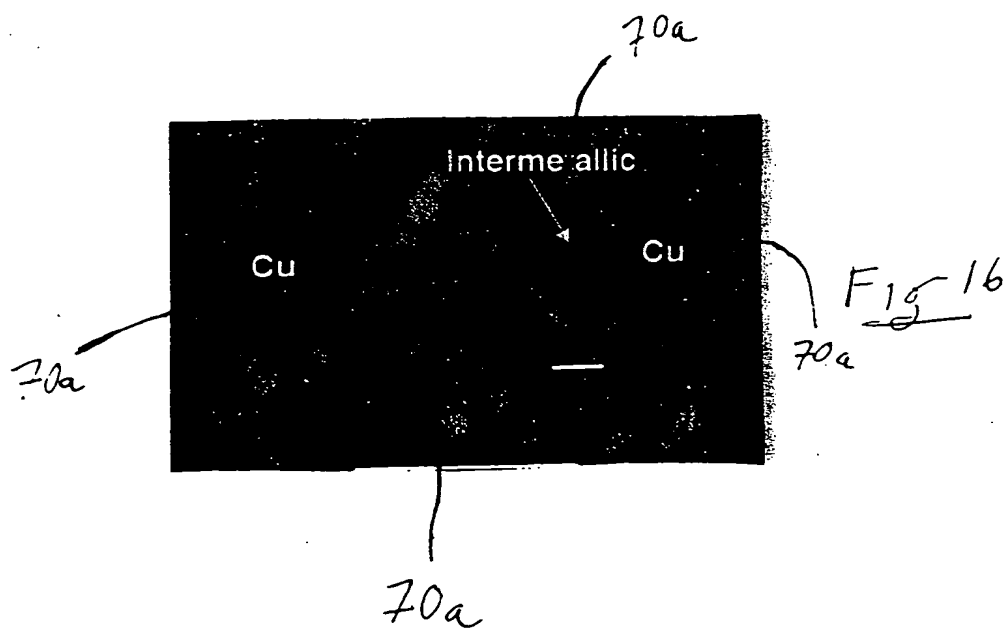
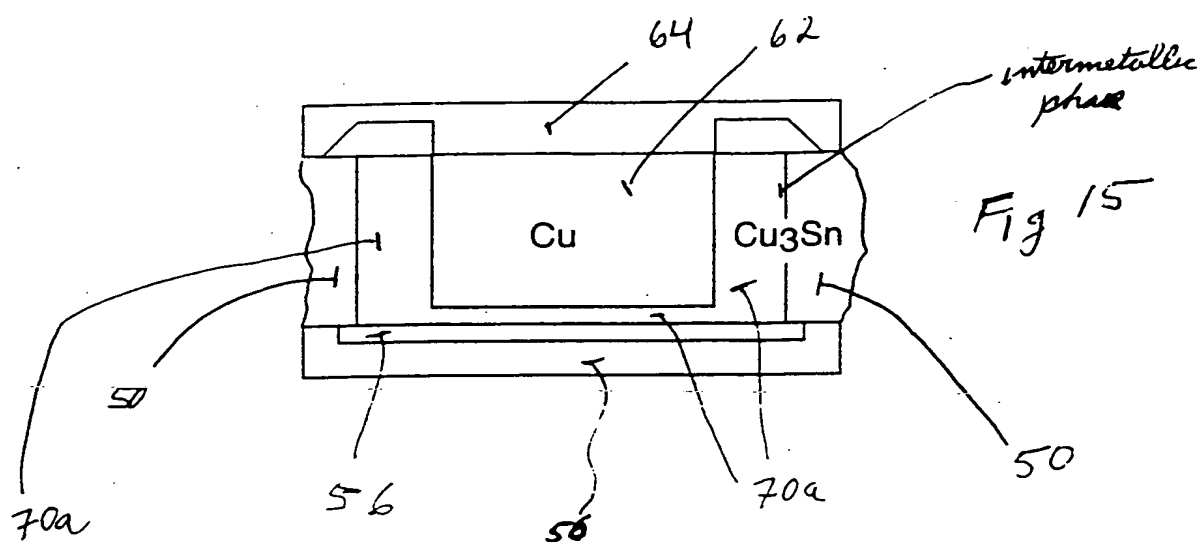
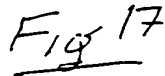


Fig 14



84



82

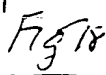
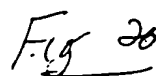


Fig 19



60



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After lamination at suitable temperature for both bonding sheet and Transient Liquid Alloy Joints, the final structure has a filled via with metal post embedded inside intermetallic wall.

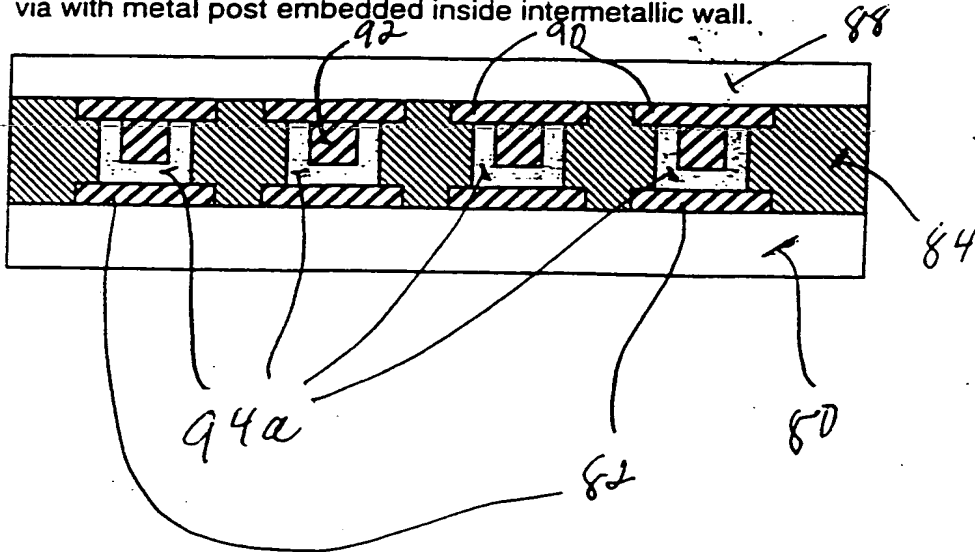


Fig 21

1005493 000100

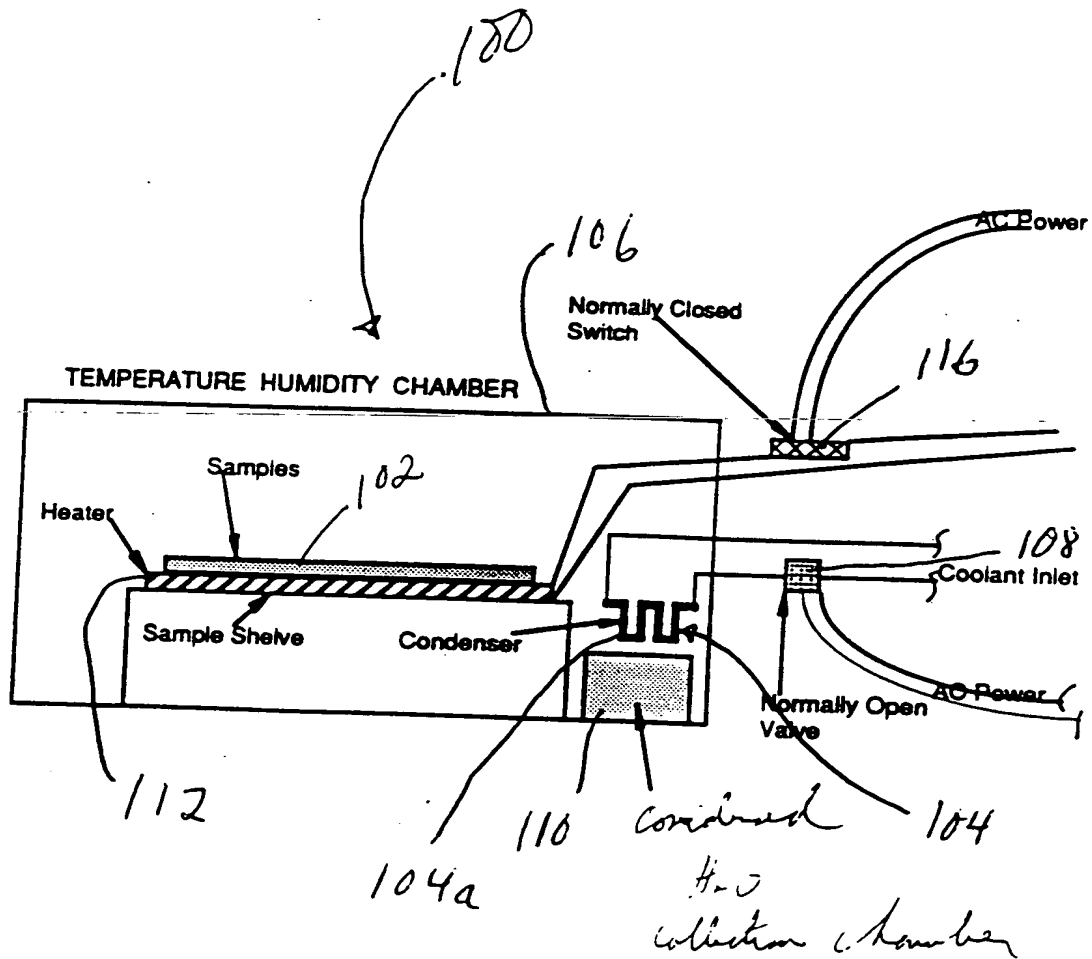


Fig 22

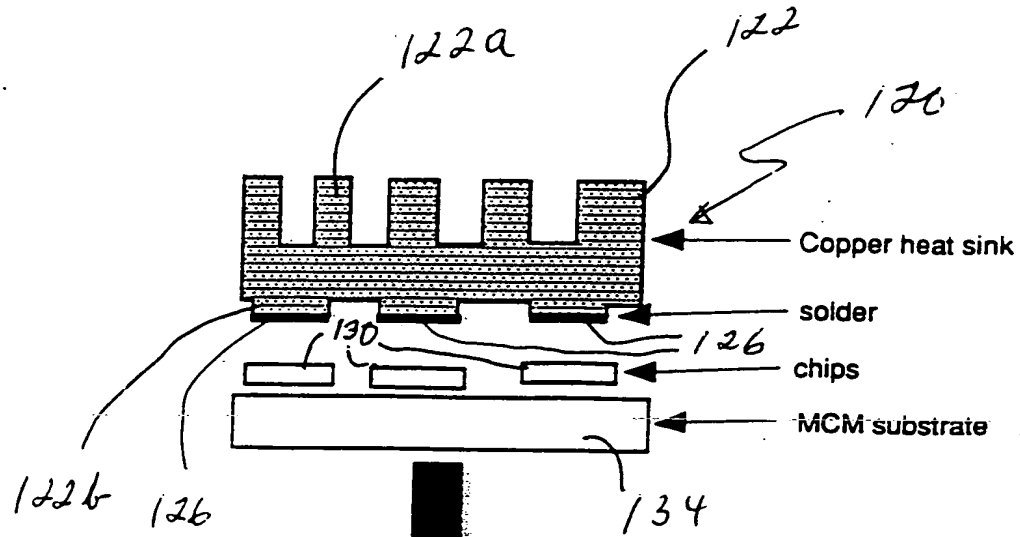
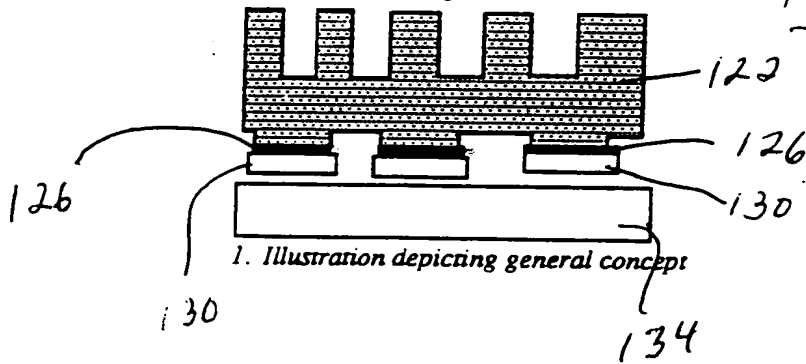
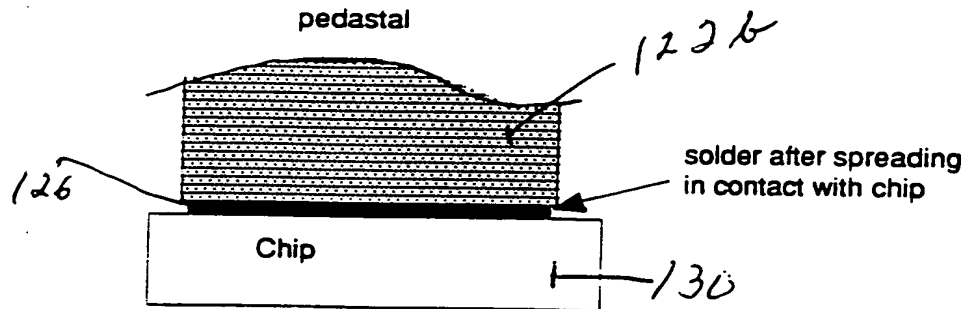


Fig. 23



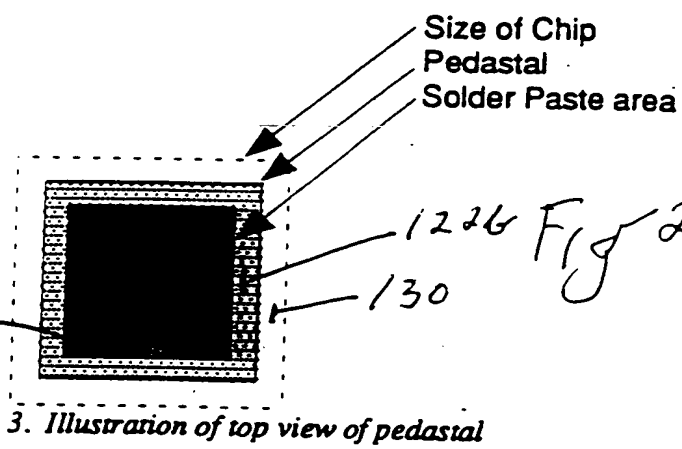
1. Illustration depicting general concept



2. Illustration of close view of solder pedestal in contact with chip

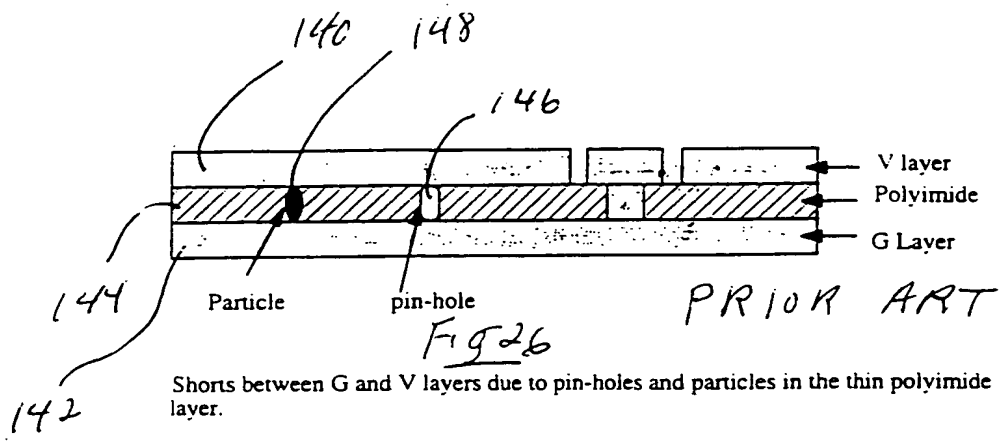
Fig 24

10066495-020102



126

10055495 020100 201020 55495001



The New Process

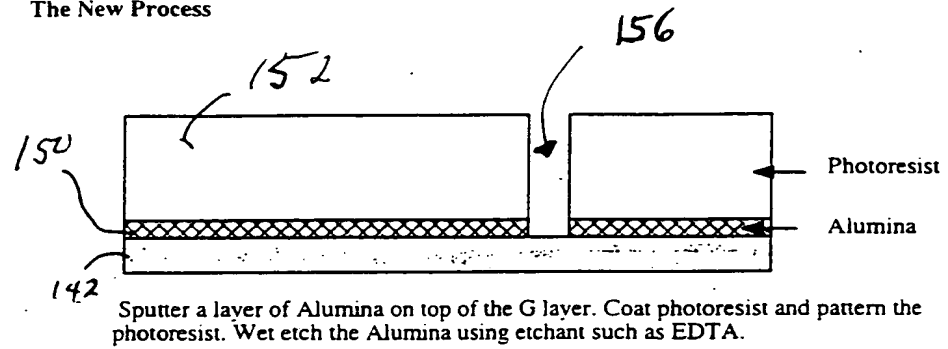


Fig 27

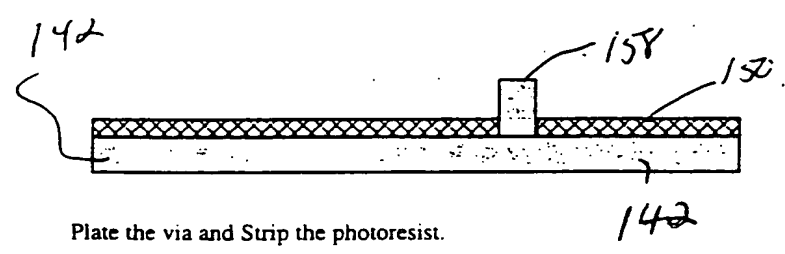
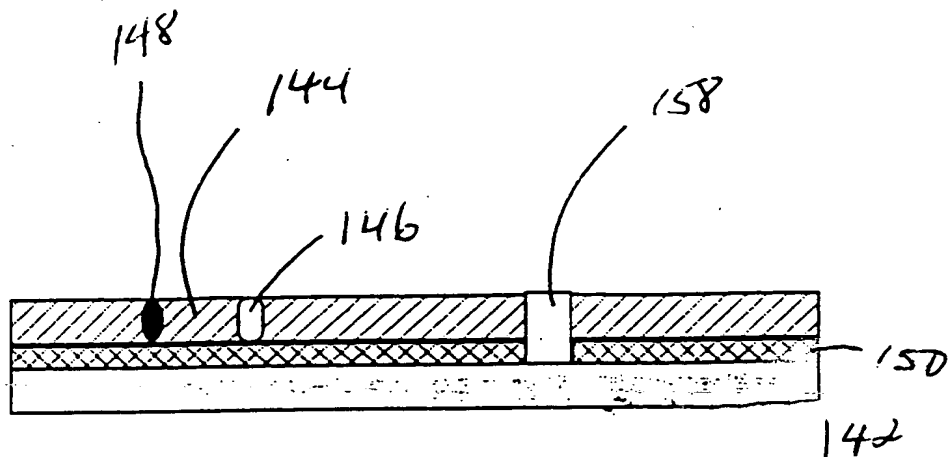
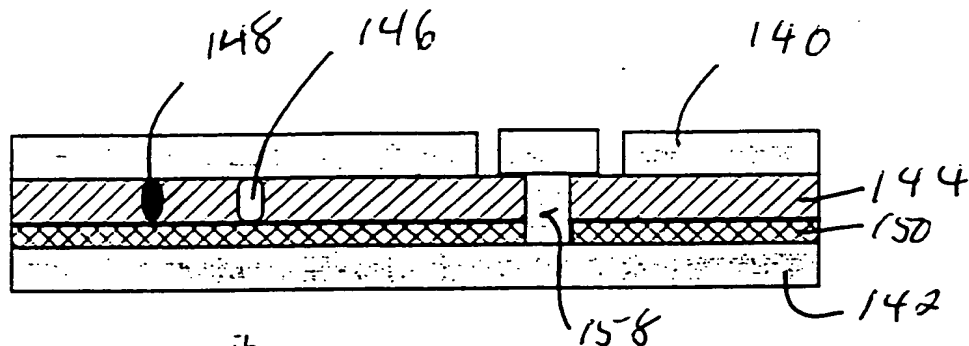


Fig 28



Coat polyimide, and then planarize and expose the vias.

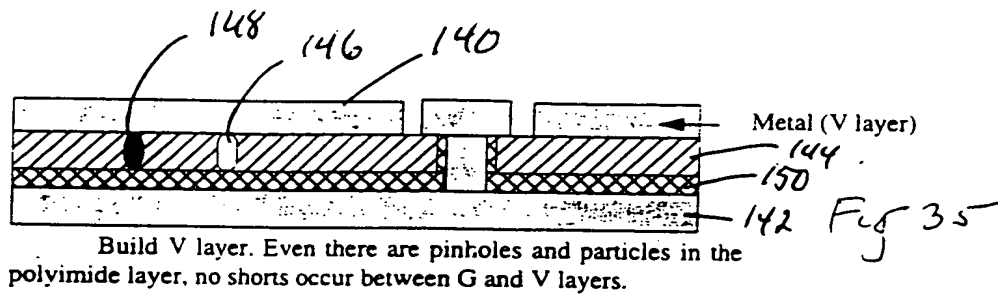
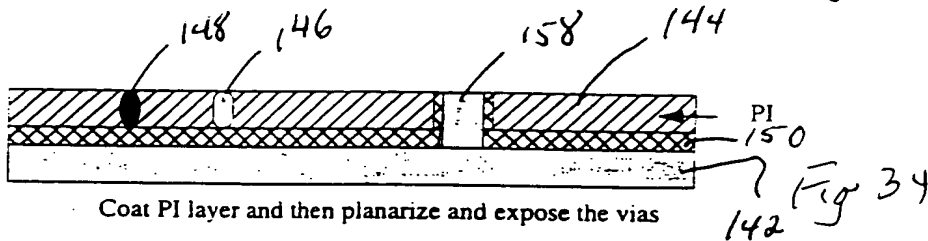
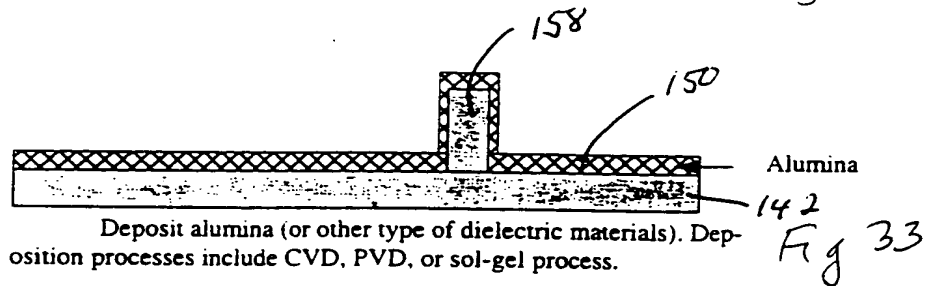
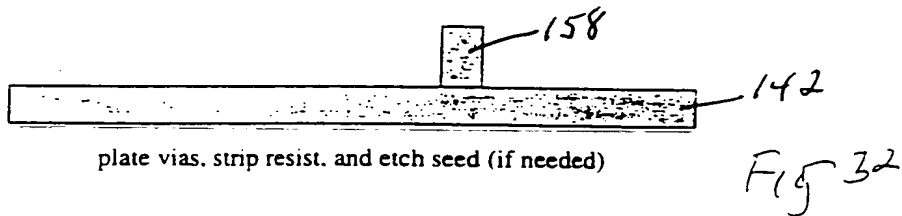
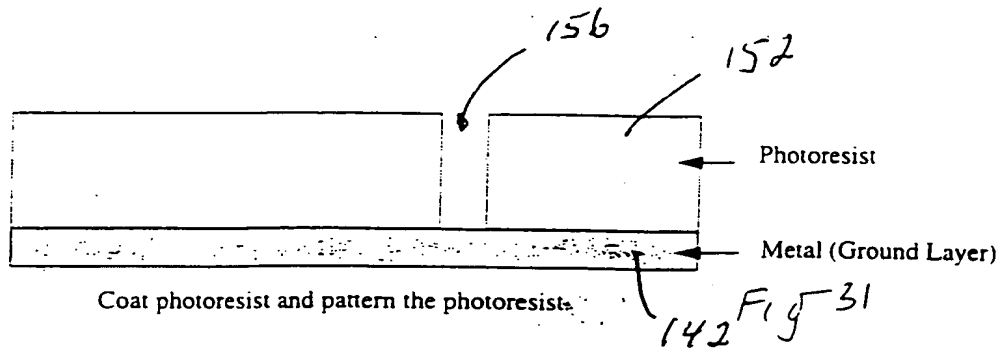
Fig 29



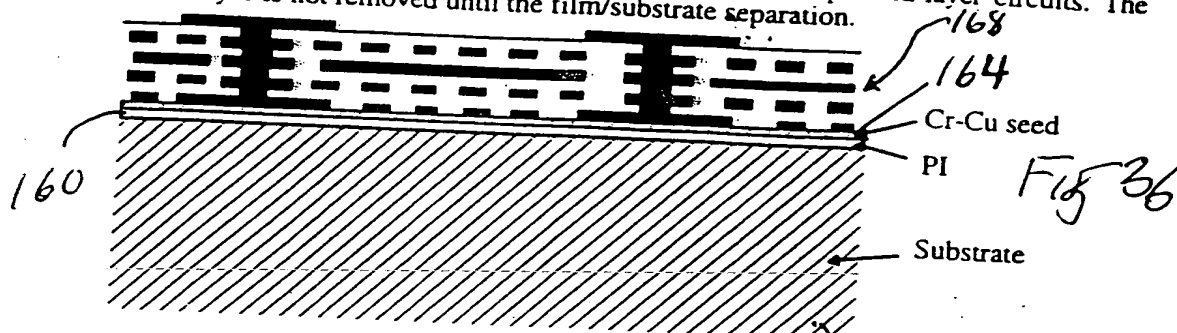
Build V layer. Even there are pin-holes and particles in the polyimide layer, no shorts occur between G and V layers.

Fig 30

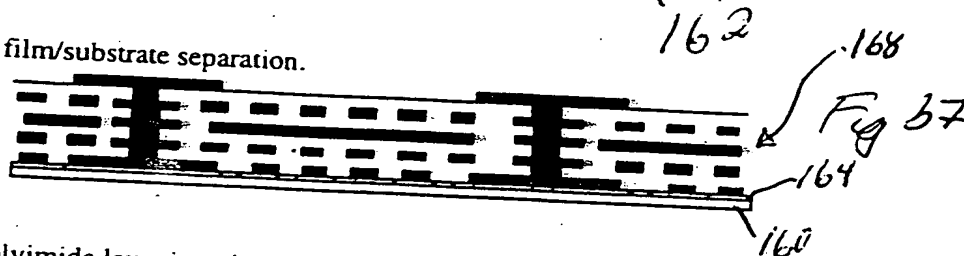
10066492 020402



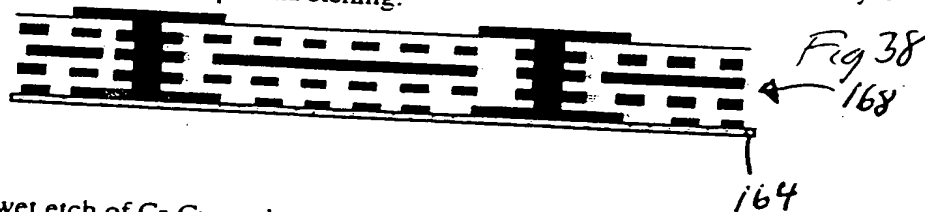
Coat a polyimide layer on top of a substrate. The substrate may be pre-treated for later film/substrate separation. Sputter Cr-Cu seed, and build up multi-layer circuits. The Cr-Cu seed layer is not removed until the film/substrate separation.



After film/substrate separation.



The polyimide layer is etched away using oxygen plasma. The Cr-Cu seed layer serves as the stop-layer for the plasma etching.



After wet etch of Cr-Cu seed.

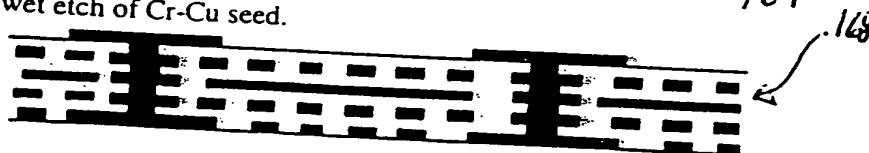


Fig 39



Fig. 40 Coat a polyimide layer on top of a substrate and sputter Cr-Cu seed on top of the polyimide. The substrate may be pre-treatment for later film/substrate separation. The seed is etched away after completing the first metal pattern layer. Multi-layer circuits are then built.

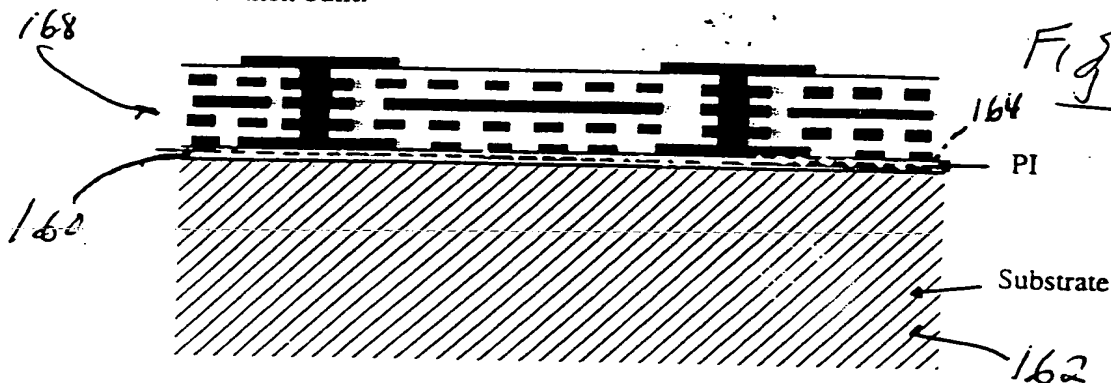


Fig. 41 After film/substrate separation

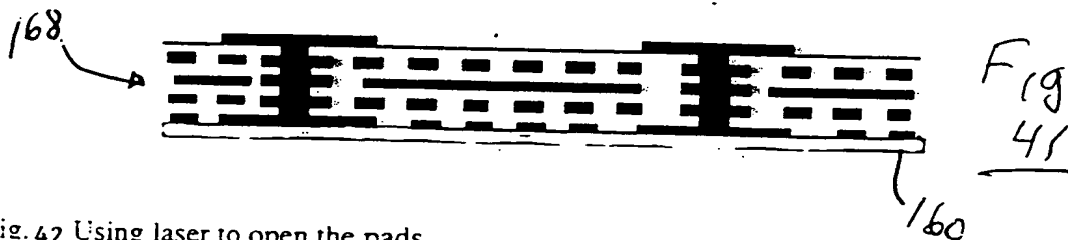
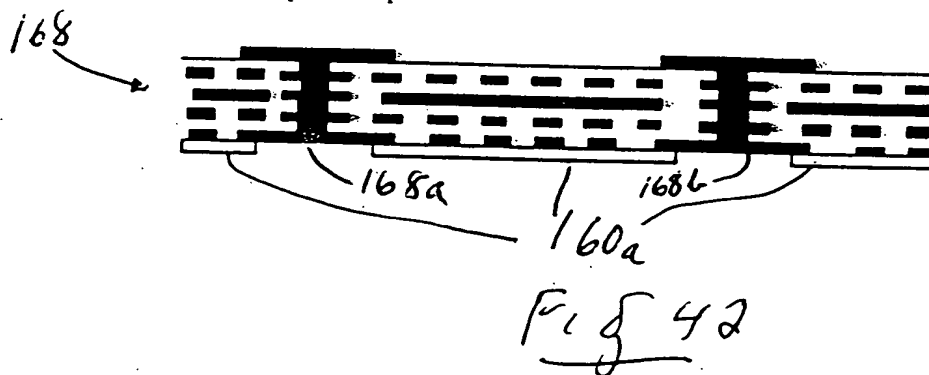


Fig. 42 Using laser to open the pads



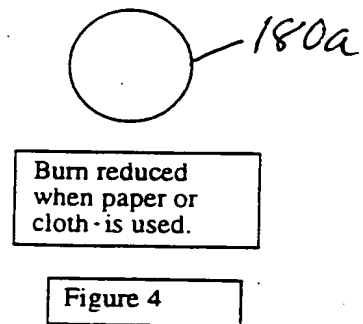
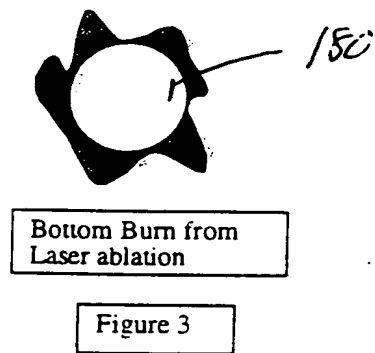
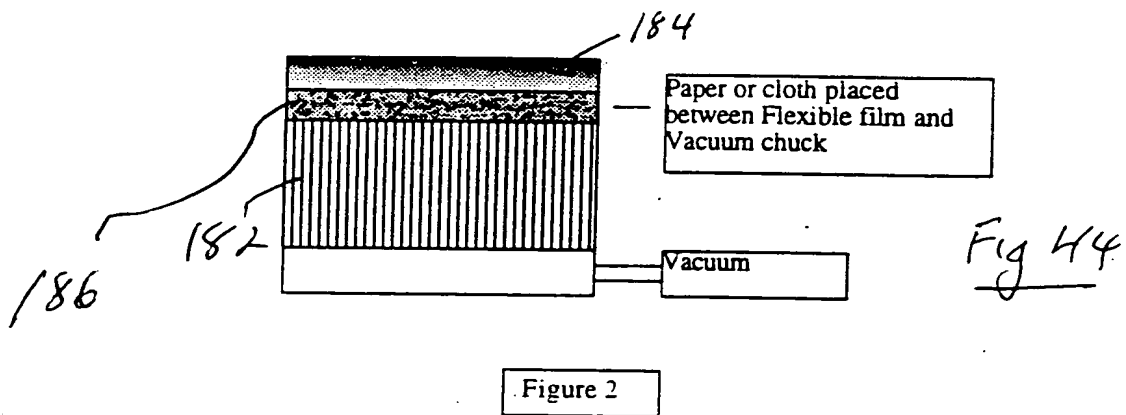
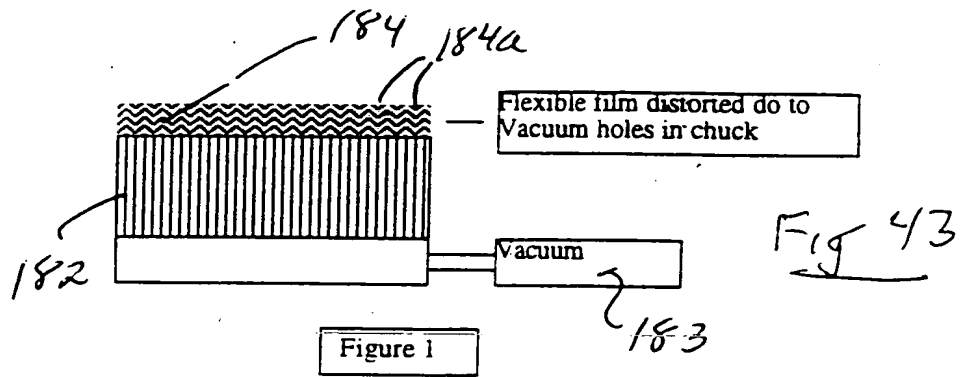
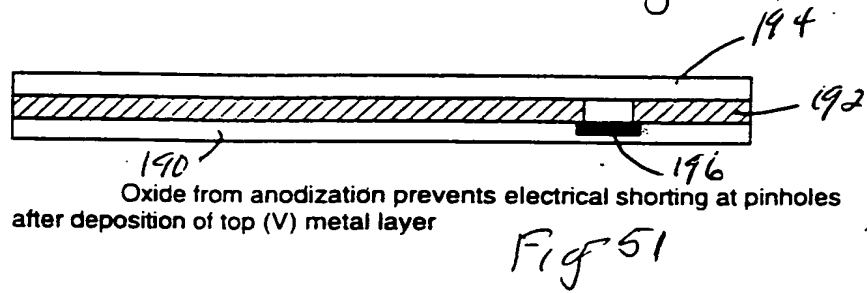
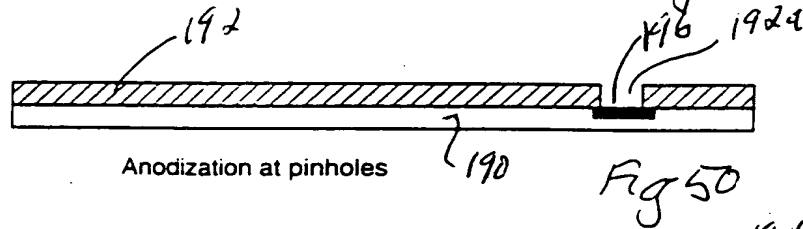
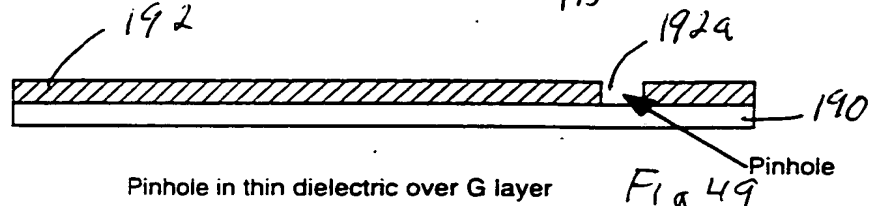
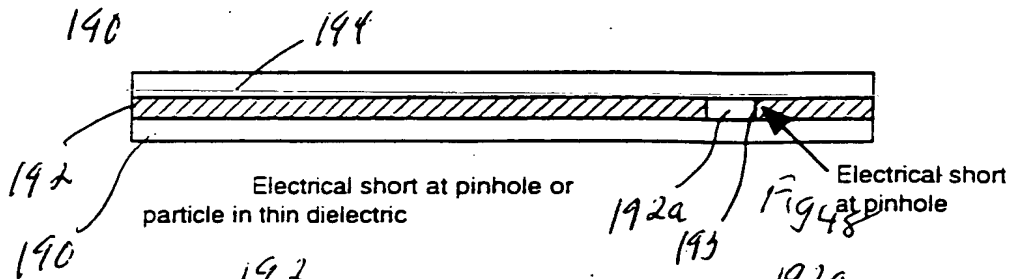
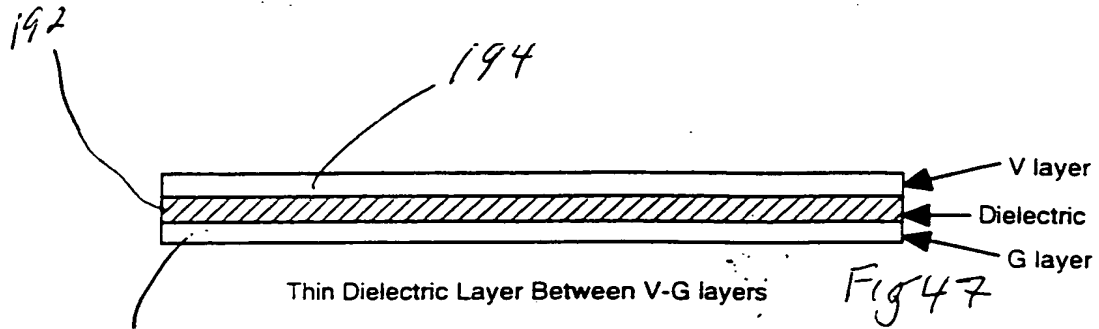


Fig 45

Fig 46



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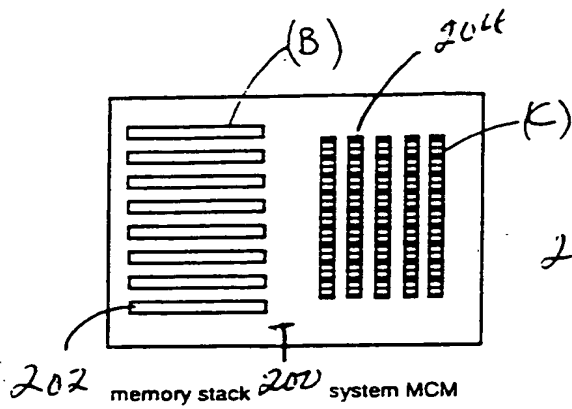


Fig 52A

Case (I)

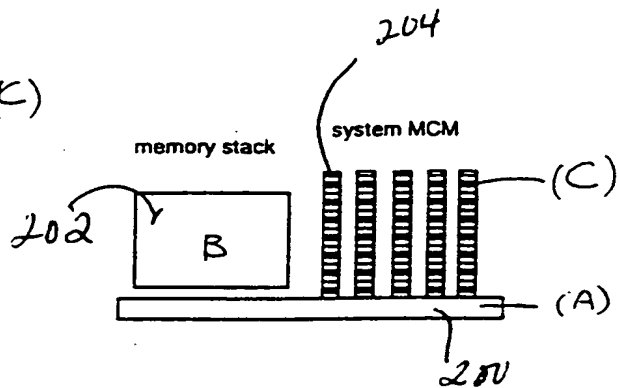


Fig 52B

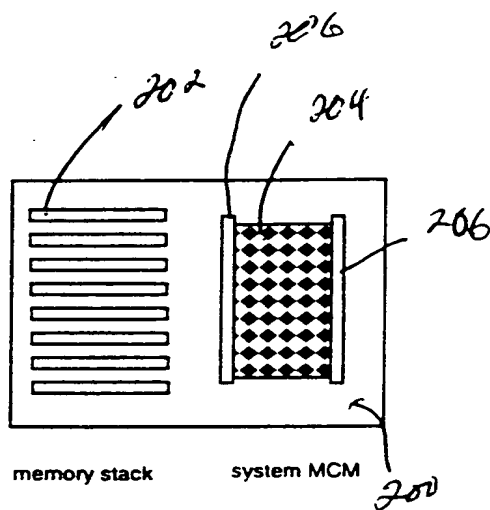


Fig 53A

Case (II)

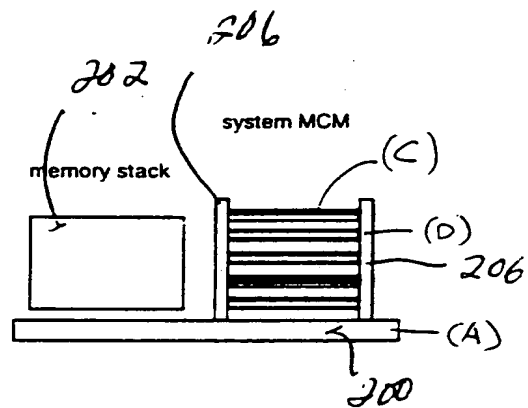


Fig 53B



10056432 200402

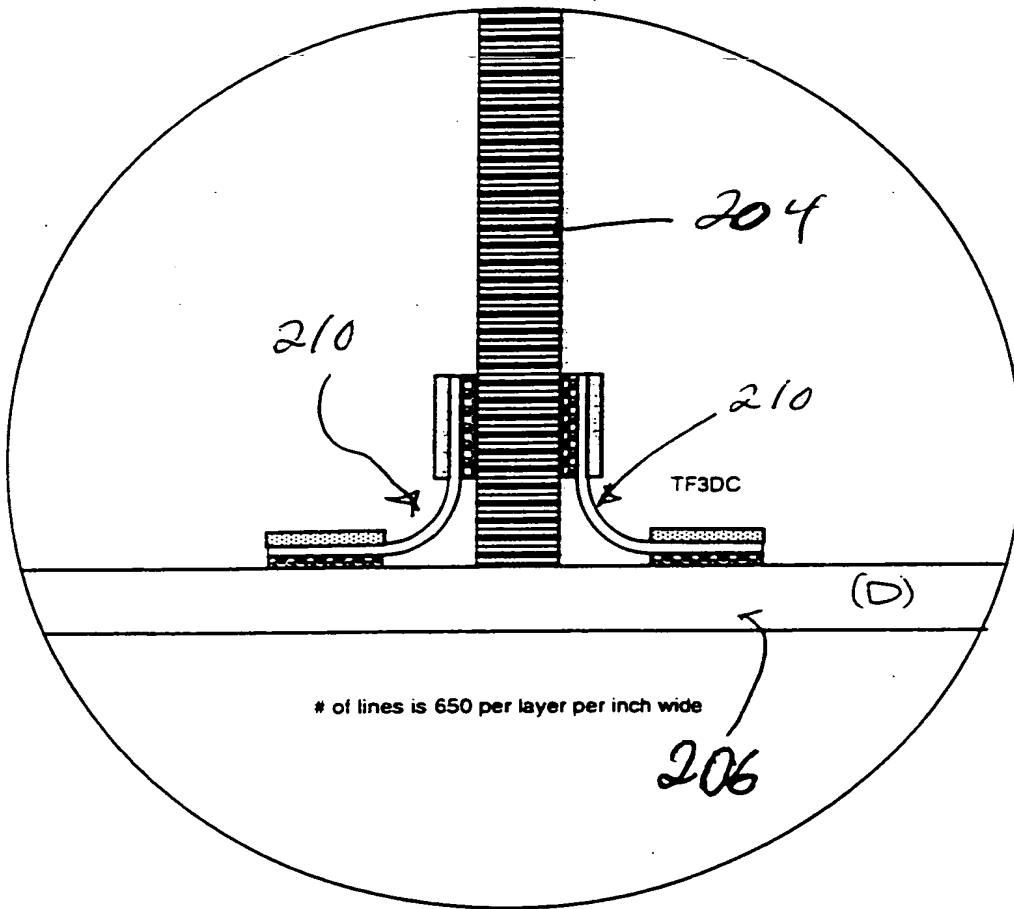
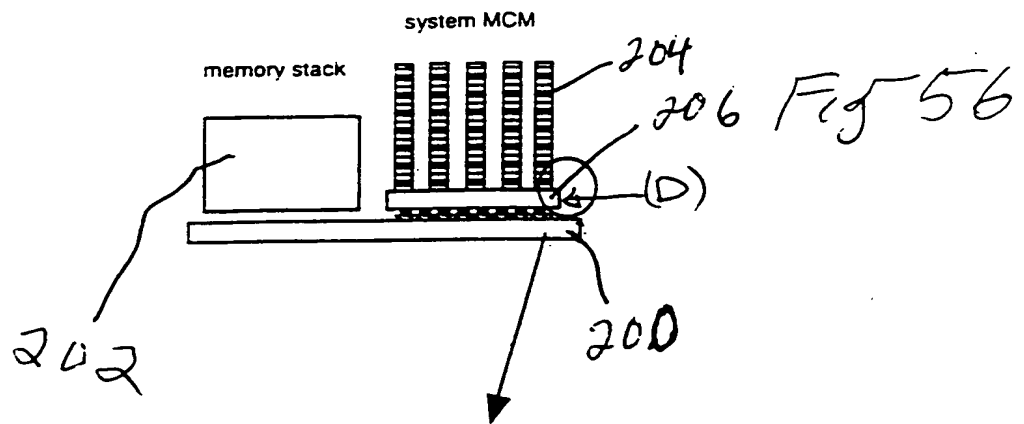


Fig 57

10054195 000407

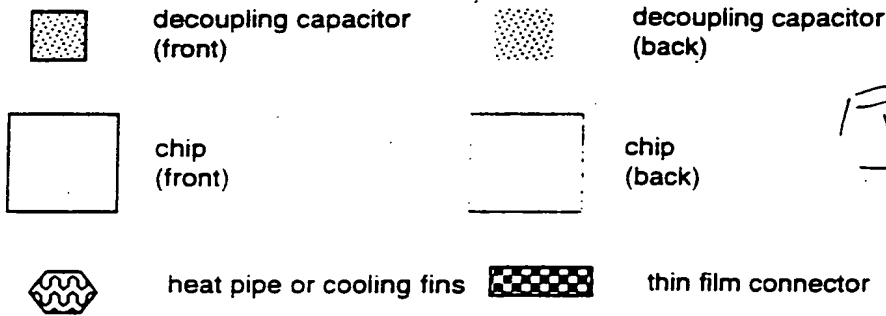
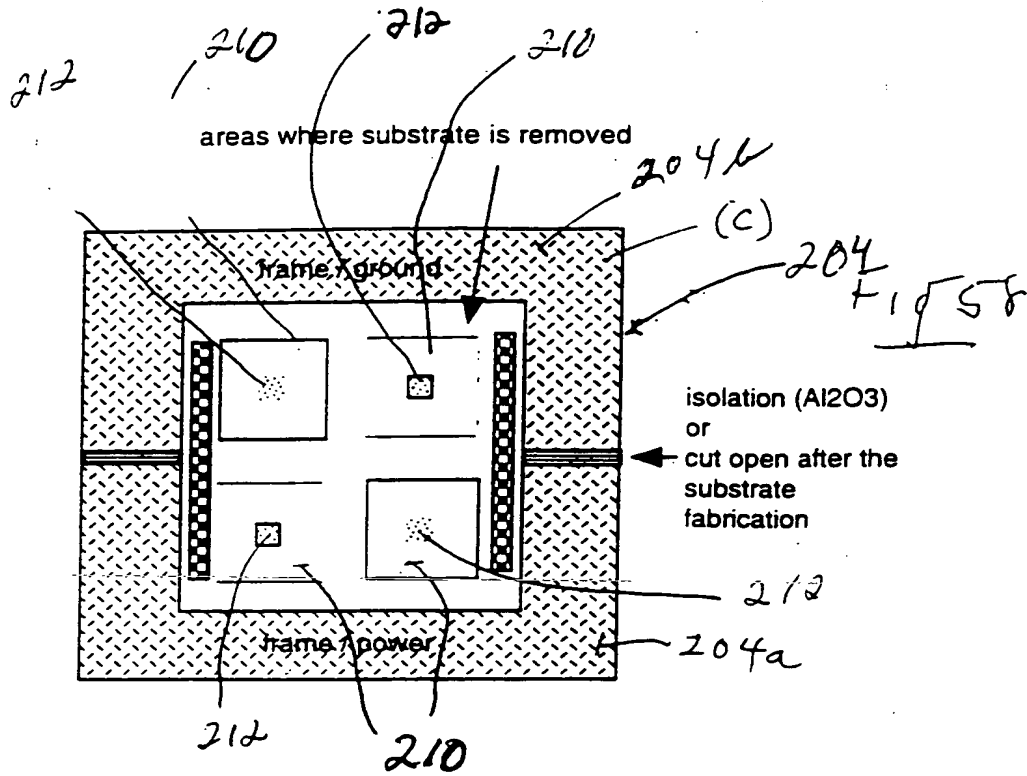


Fig 59

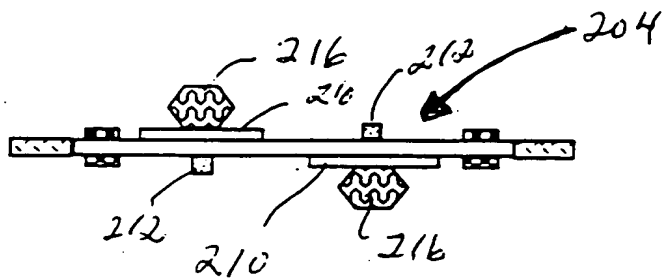
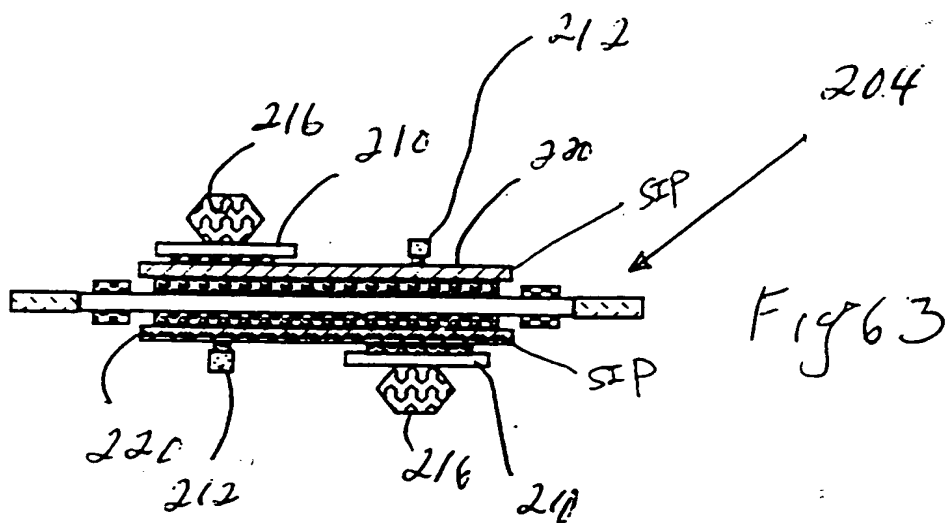
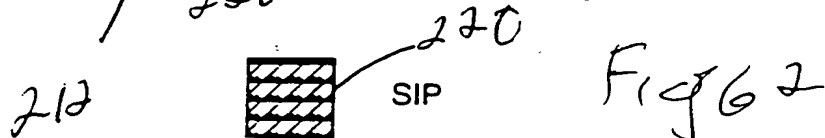
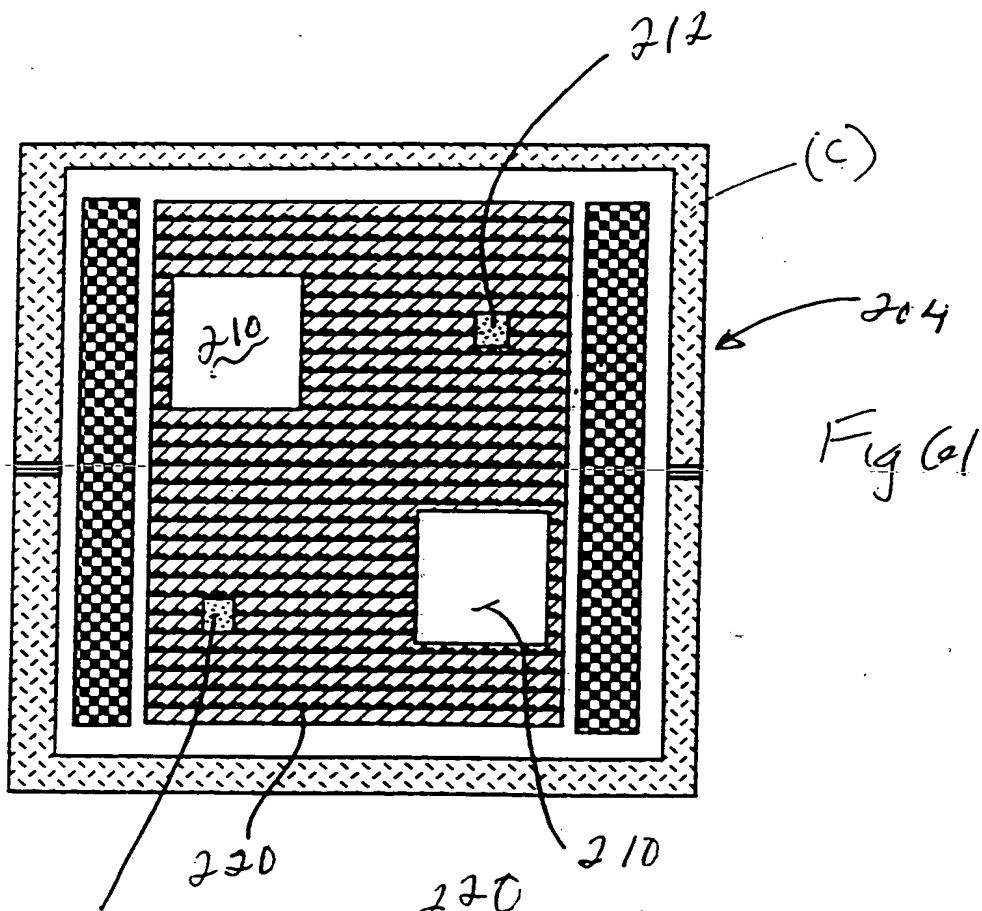
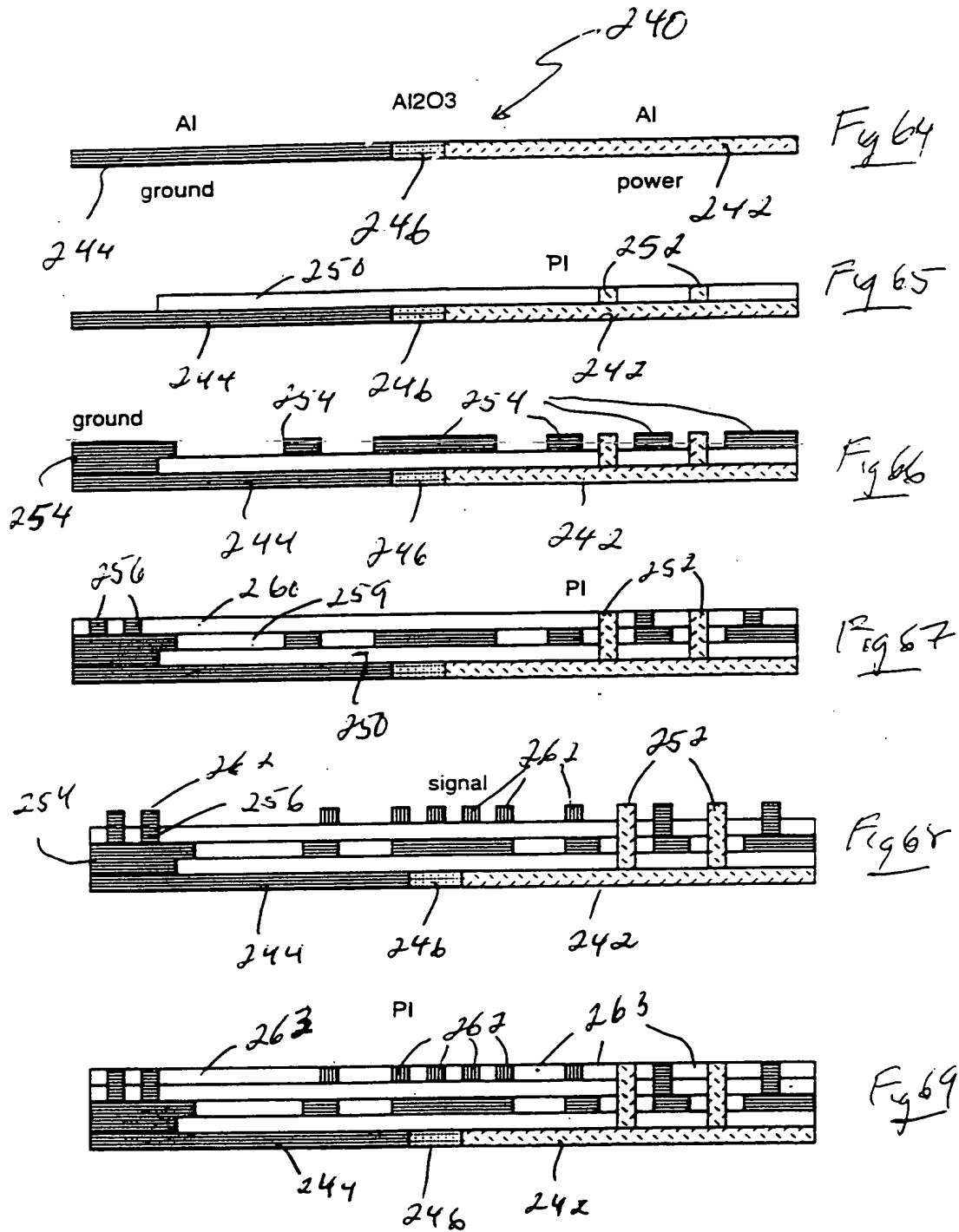


Fig 60

100545-0343 55755001







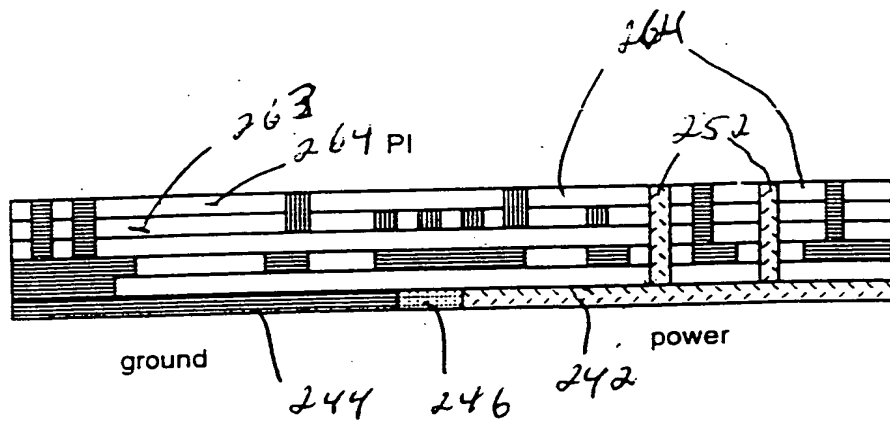


Fig 70

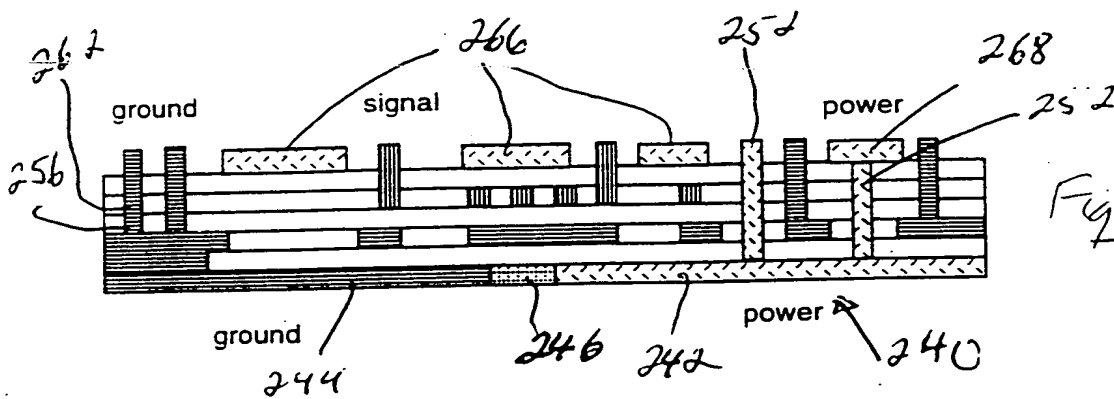


Fig 71

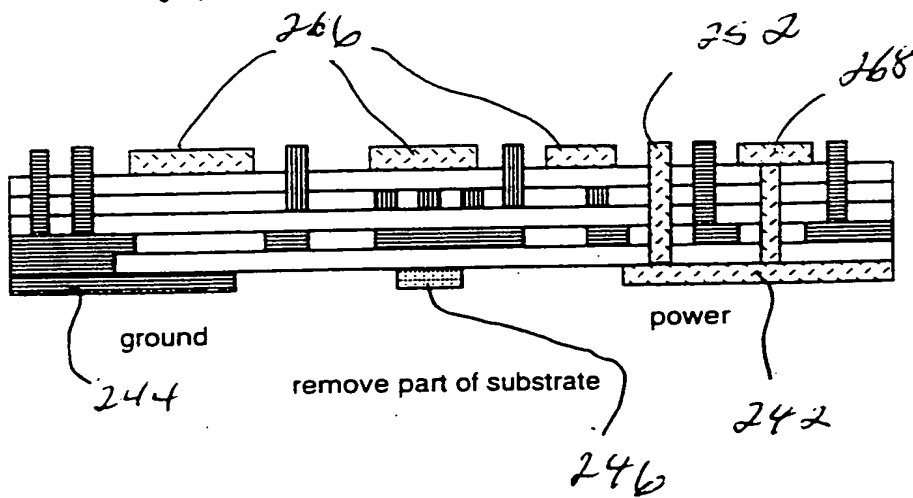
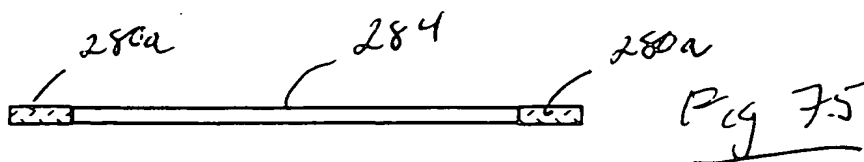
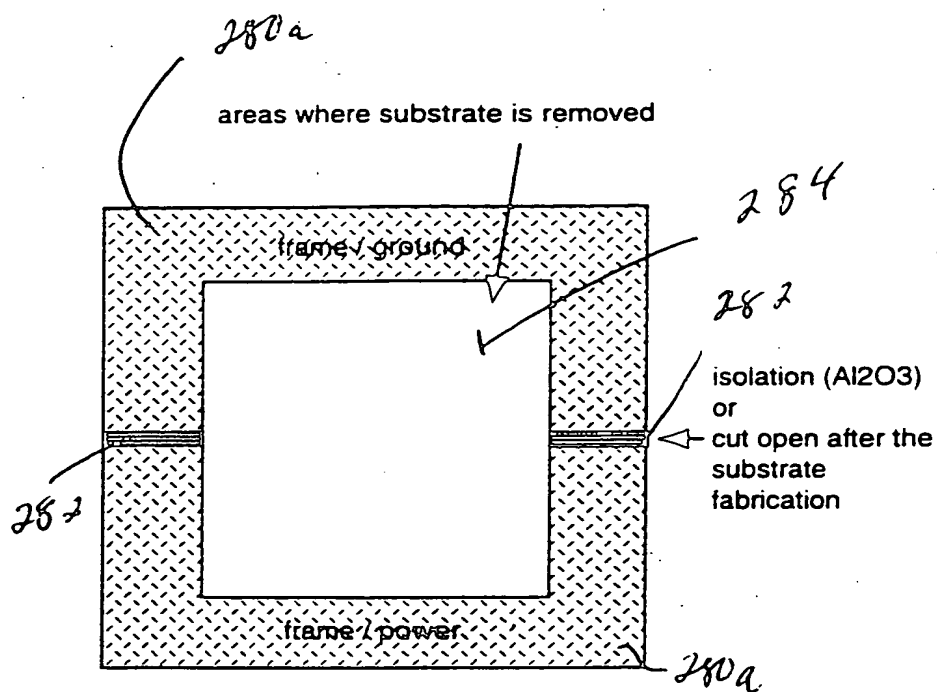
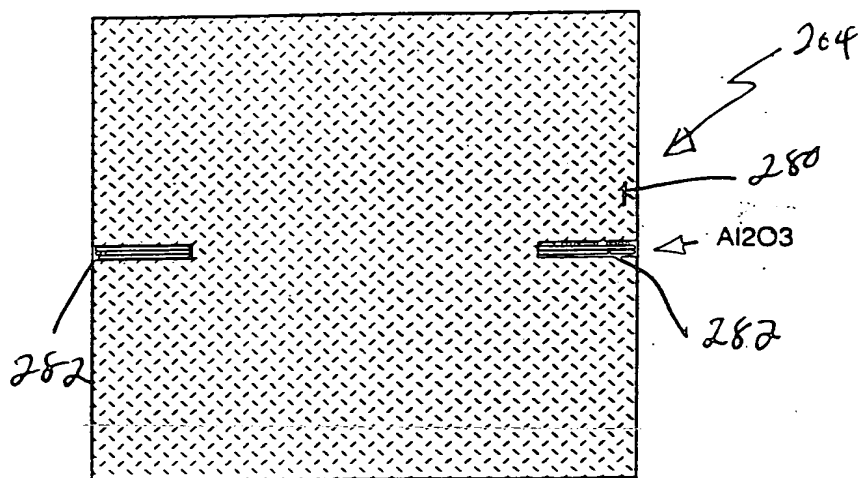
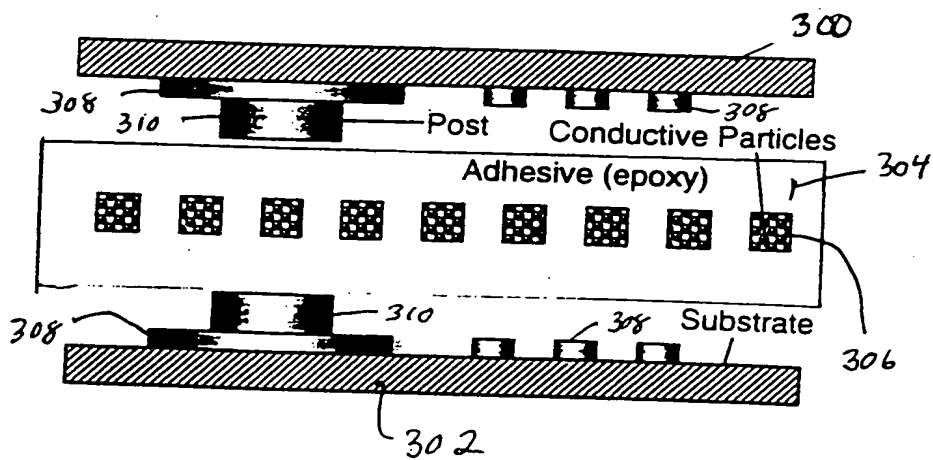
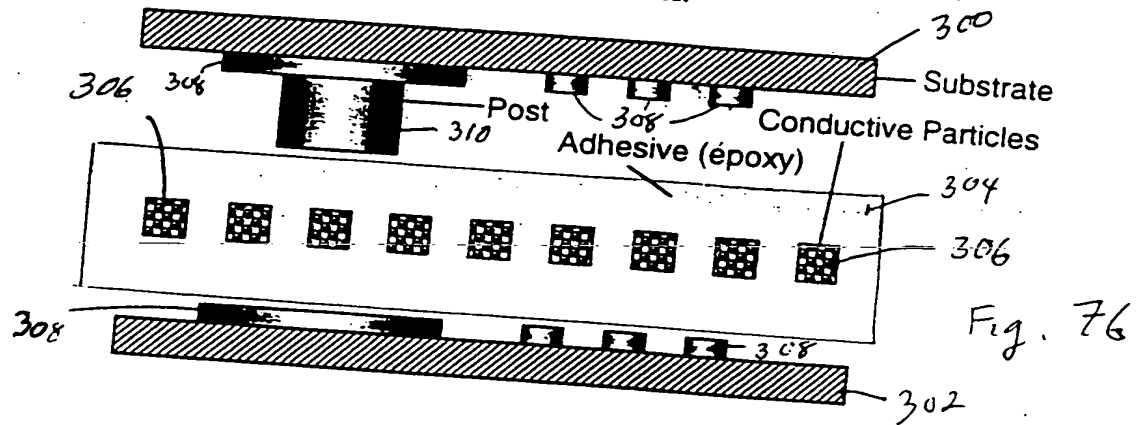


Fig 72



Traditional process for anisotropic conductive film (ACF)  
connection process for joining two substrate.



1006495-020402

ACF connection after lamination under high pressure and high temperature in traditional ACF process

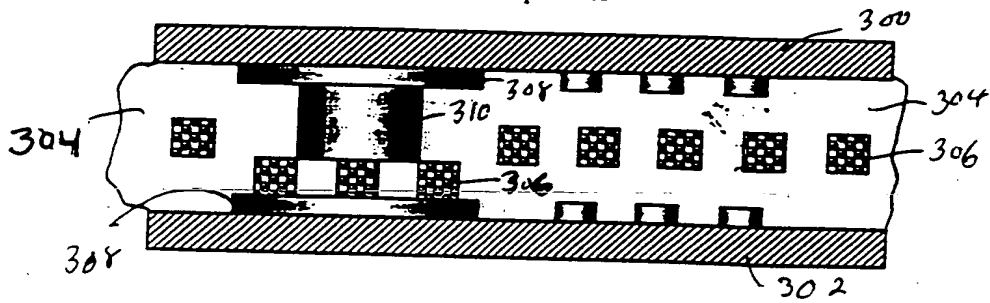


Fig 78

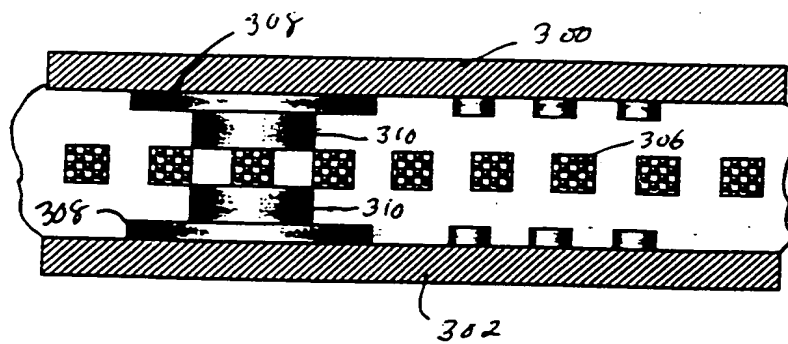


Fig 79

Low resistance ACF joints by depositing a thin layer of low-melting-point metal that will form intermetallic compound/alloy between post material and conductive particles in ACF.

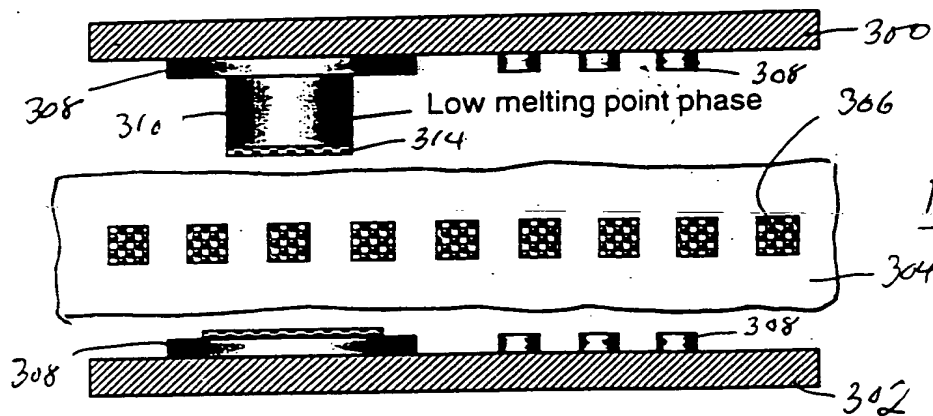


Fig 80

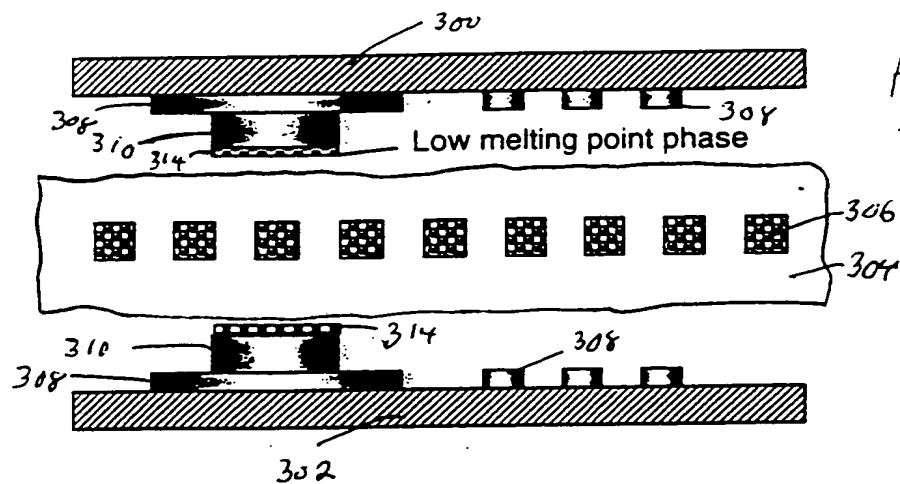
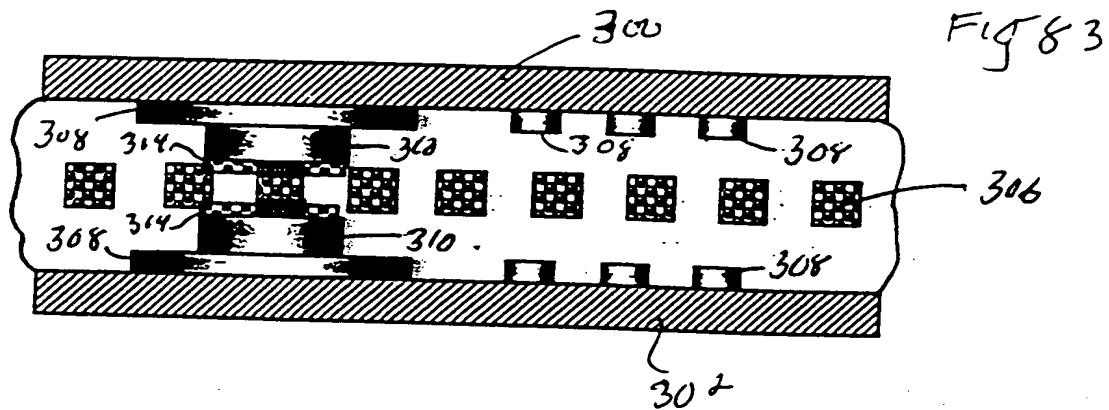
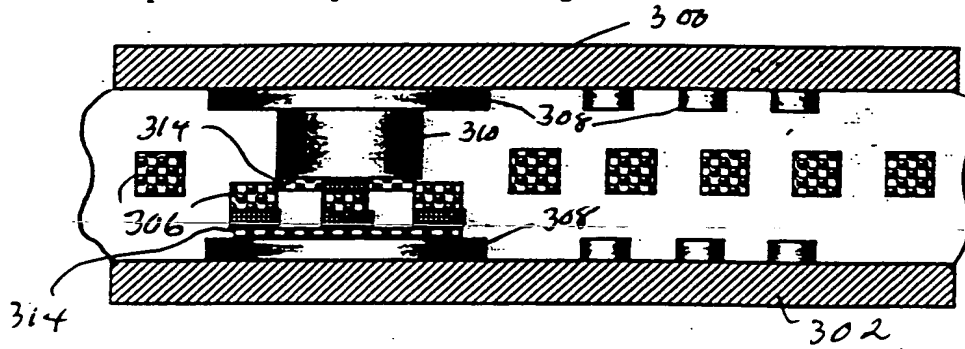


Fig 81

After joining process (high pressure and high temperature), intermetallic/alloy formed at the interface of post and conductive particles. The intermetallic/alloy will decrease the contact resistance from traditional ACF process and provide a stronger mechanical bond.



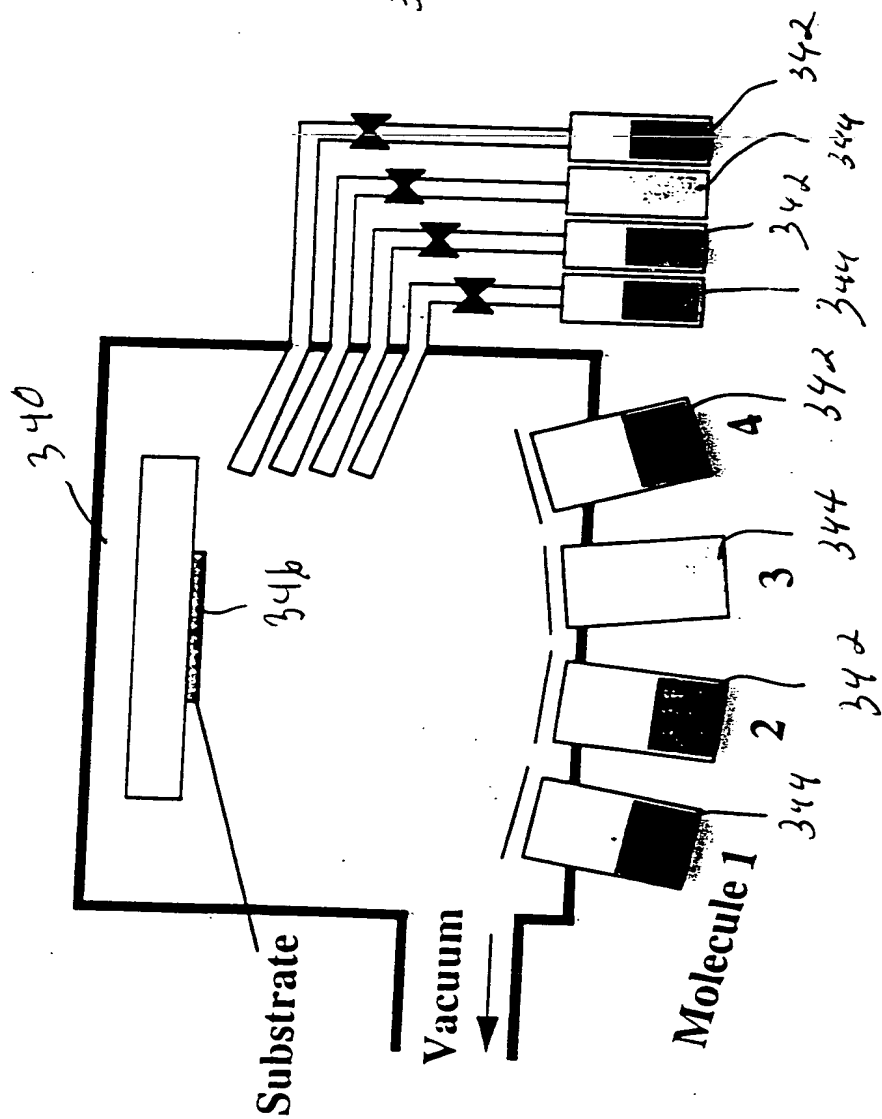


Fig 84A

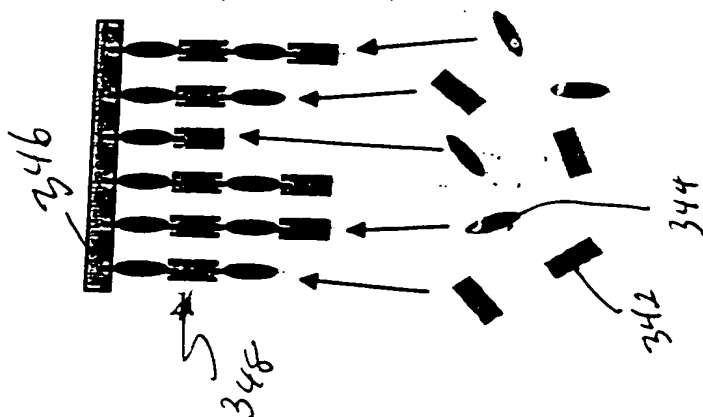


Fig-84B



Fig. 85A

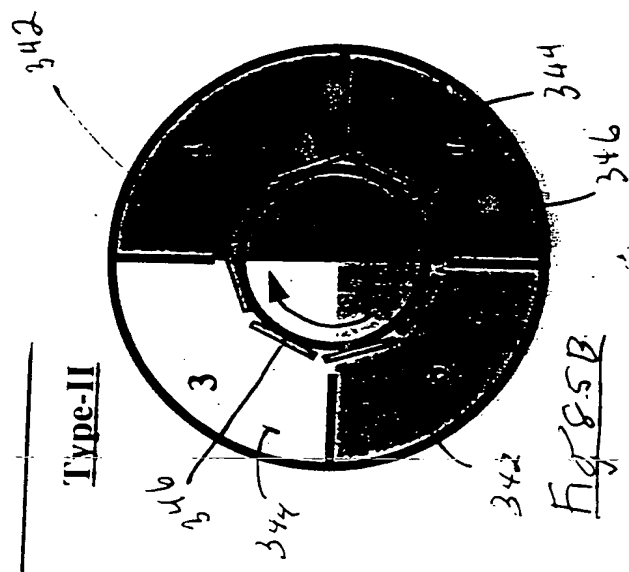
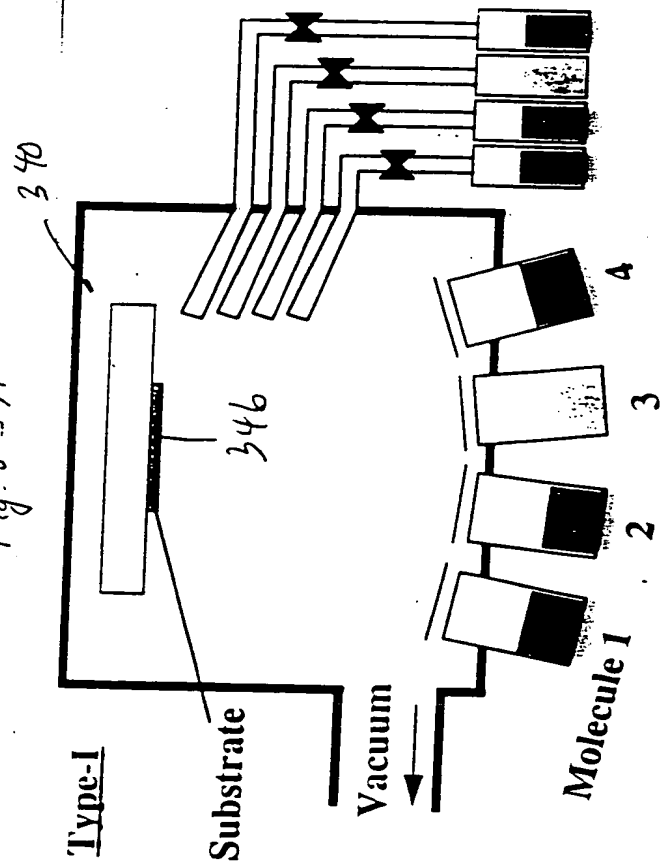
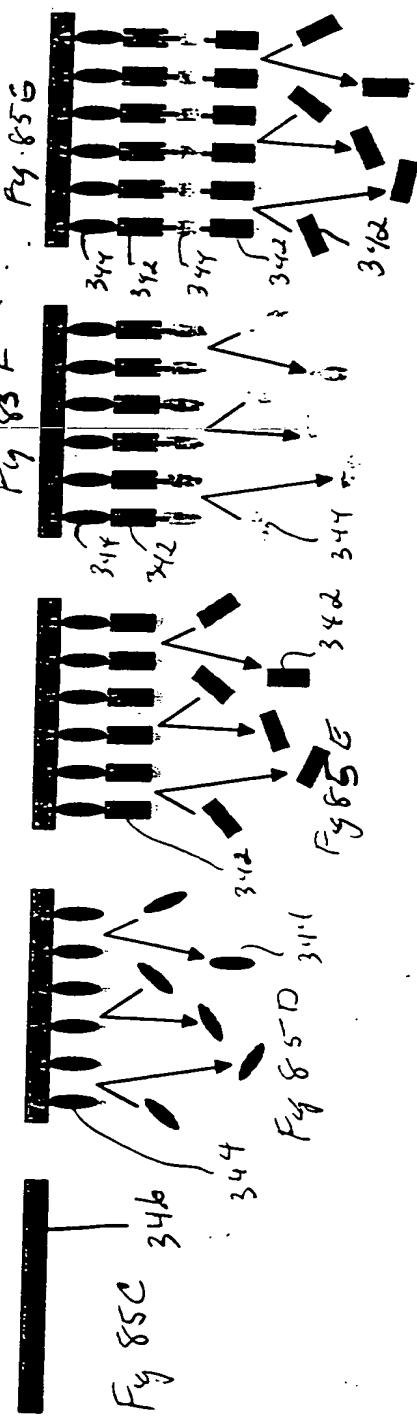


Fig. 85B



## Vapor Phase Deposition Vs. Spin coating

	Spin coating	Vapor Phase Deposition	
		CVD	MLD
-Coverage Controllability	Low	High	High
-Thickness Accuracy/Uniformity	Low	Medium	High
-Deposition Rate	High	Medium	Low
-Molecular-level Controllability	Low	Medium	High
-Selective Deposition	No	Yes	Yes
Selective Molecular Alignment	No	Yes	Yes

(High & Yes are preferable)

-Conformable coverage and Thickness accuracy/uniformity

-CVD/MLD are superior to Spin Coating

-Low  $\epsilon$  insulator with strong adhesion

-MLD may provide high adhesion with the Molecular-Level Controllability

-Options

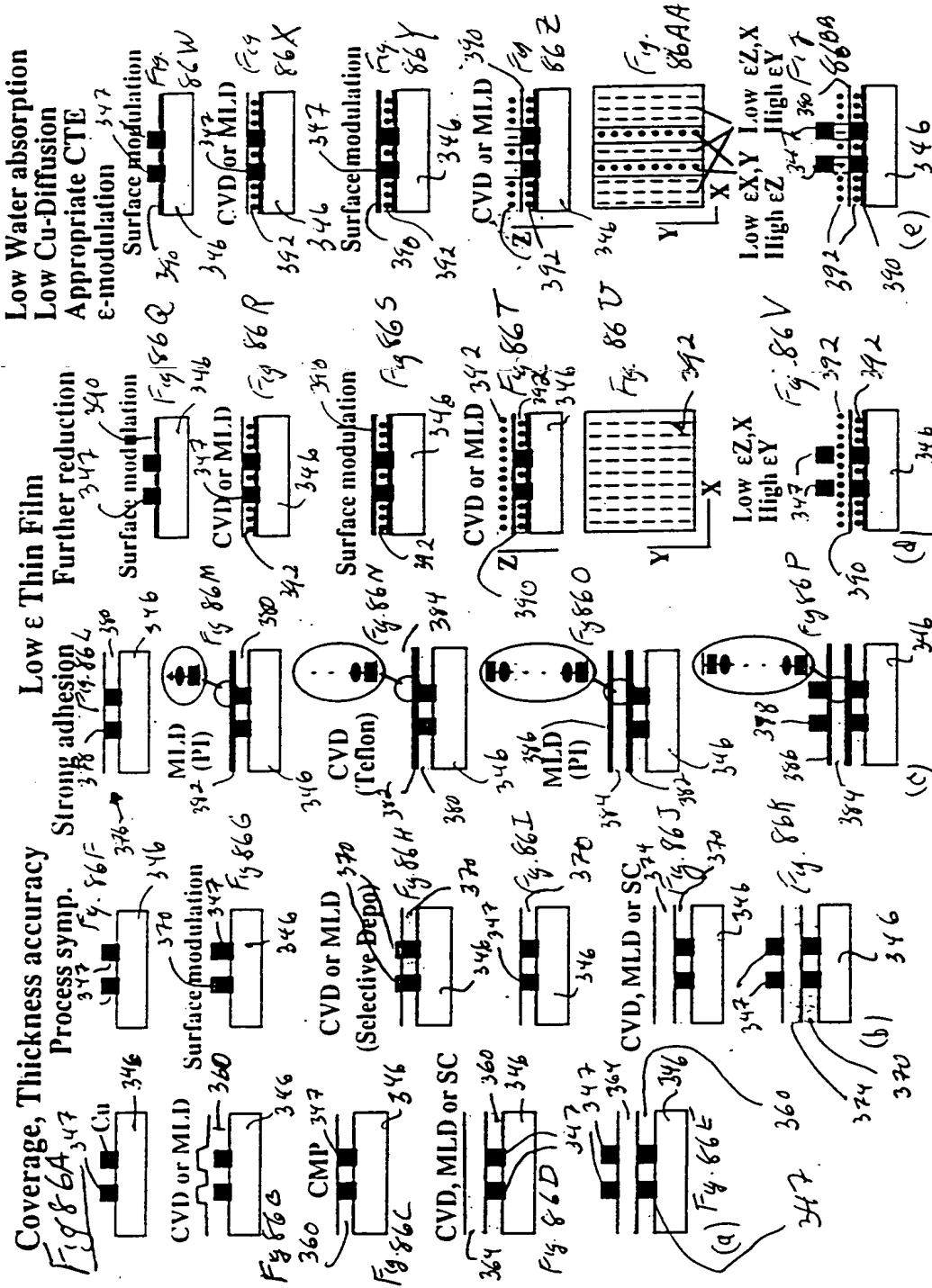
-CVD/MLD can do # Selective Deposition (hydrophilic/hydrophobic surface)

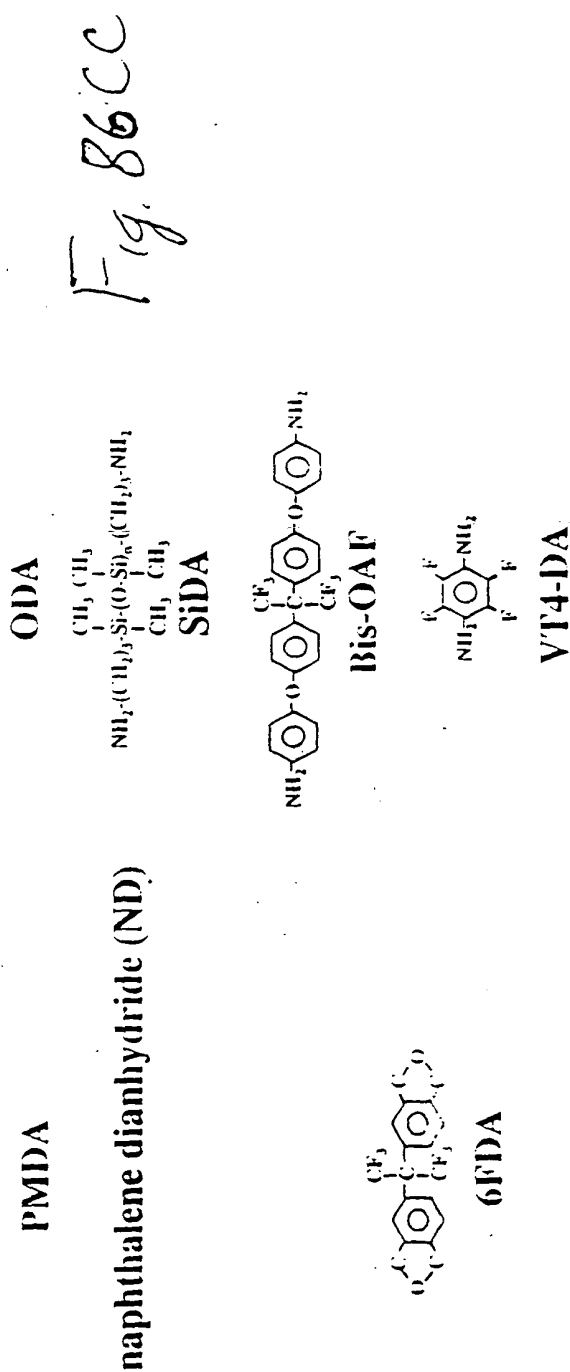
# Selective Molecular Alignment (surface treatment)

may provide further  $\epsilon$  reduction, process simplification, and low Cu-diffusion

Fig 8514

# Examples of MLD & CVD application to MCM processes





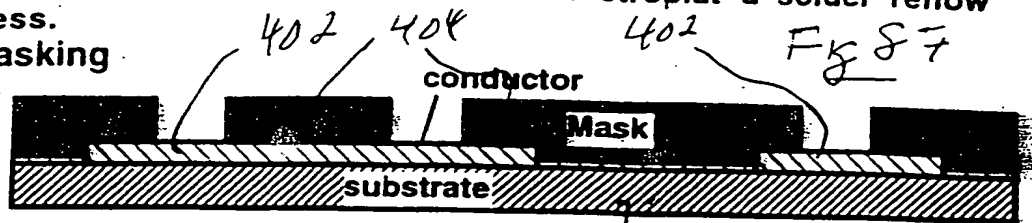
alkylamine-coated Si | ND  $\Rightarrow$  Bis-OAF  $\Rightarrow$  ND  $\Rightarrow$  Bis-OAF  $\Rightarrow$  ...  $\Rightarrow$  ND  $\Rightarrow$  SiDA

Si | SiDA  $\Rightarrow$  6FDA  $\Rightarrow$  Bis-OAF + 6FDA  $\Rightarrow$  SiDA

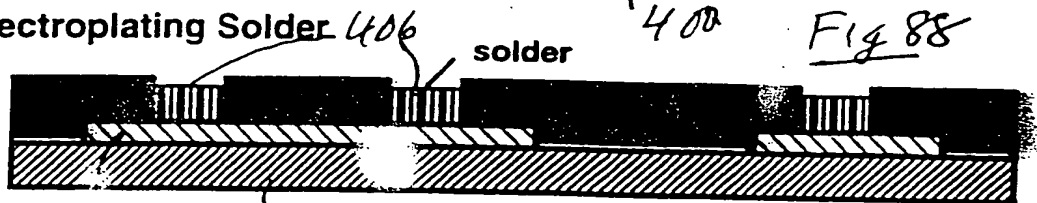
Si | SiDA  $\Rightarrow$  ODA  $\Rightarrow$  6FDA  $\Rightarrow$  VT4-DA  $\Rightarrow$  6FDA  $\Rightarrow$  ...  $\Rightarrow$  ODA  $\Rightarrow$  SiDA

Process flow of the resist-free electroplated solder reflow process.

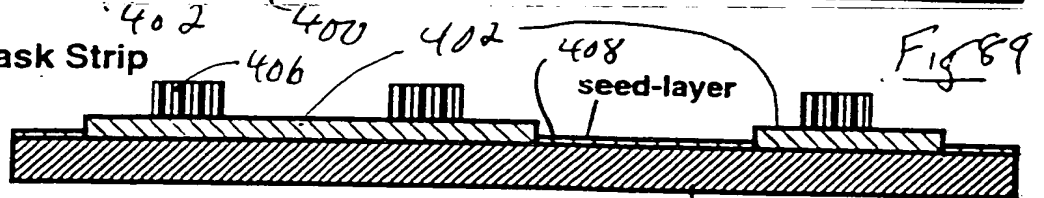
1. Masking



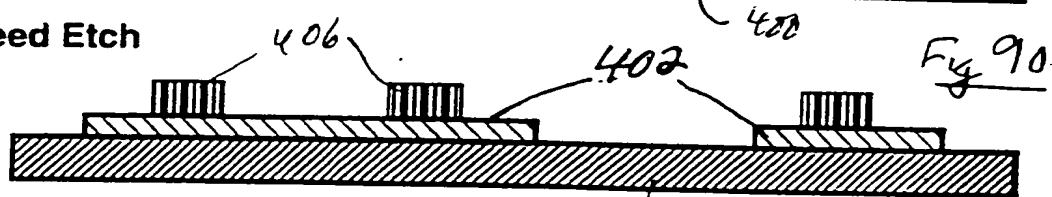
2. Electroplating Solder



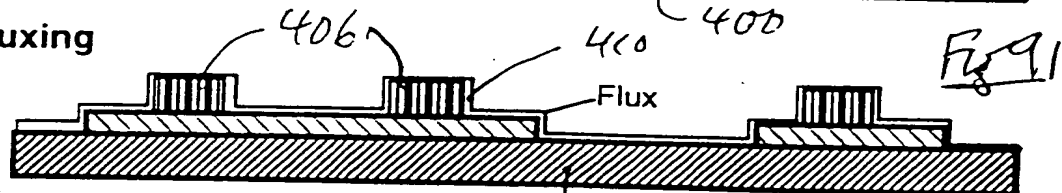
3. Mask Strip



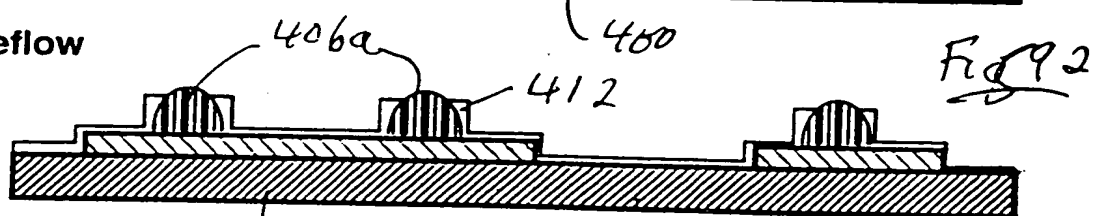
4. Seed Etch



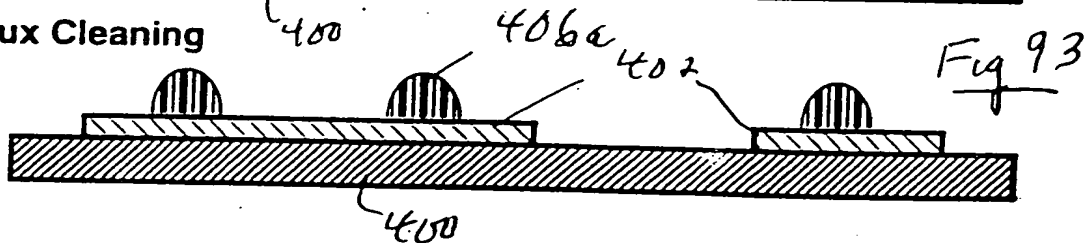
5. Fluxing



6. Reflow



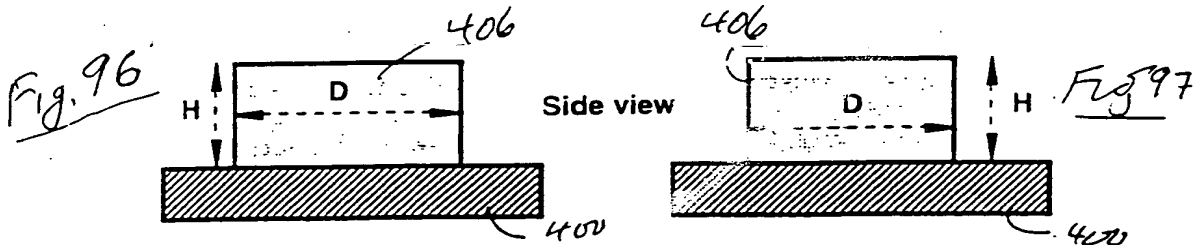
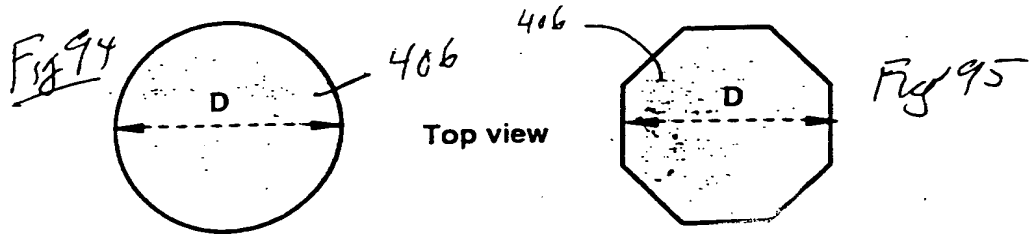
7. Flux Cleaning



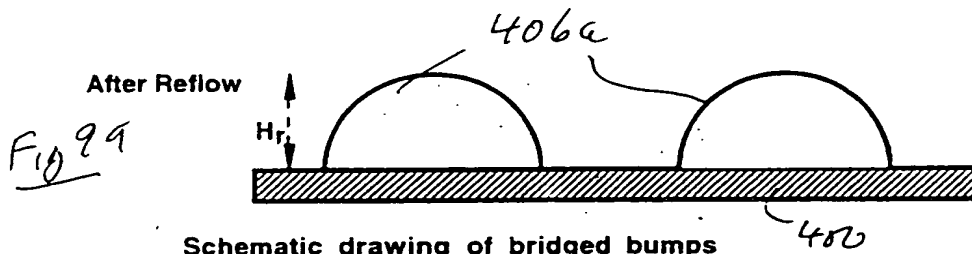
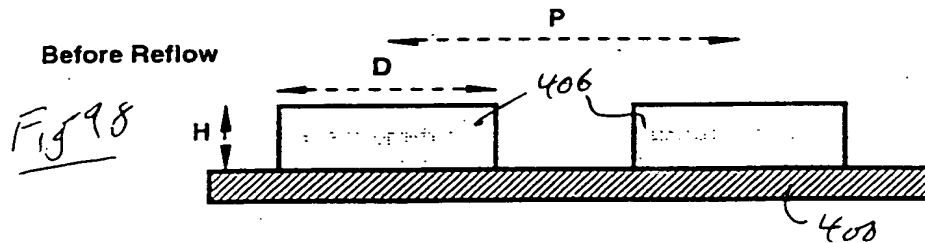
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Geometric dimensions of the electroplated bumps.

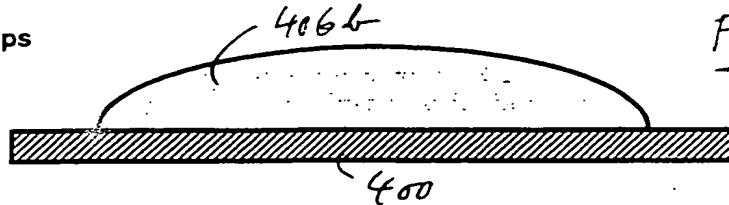


Geometric shape change of electroplated solder bumps by reflow process



Schematic drawing of bridged bumps

Bridged Bumps



## Direct Plating Process

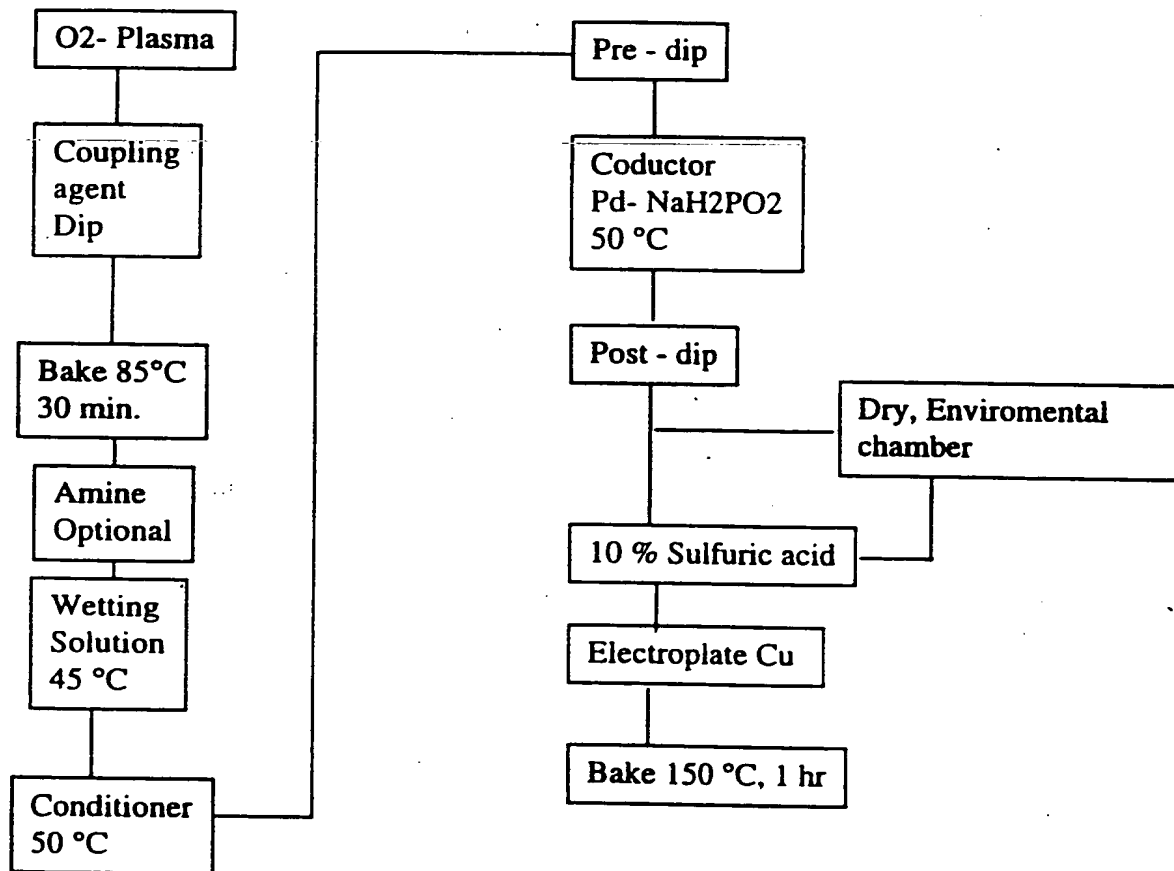
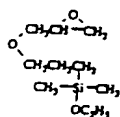
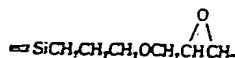
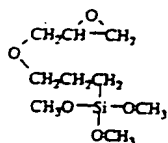


Fig 101A

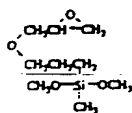
Fig 101B



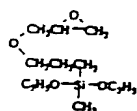
(3-GLYCIDYOXYPROPYL)DIMETHYLETHOXY-SILANE  
C<sub>10</sub>H<sub>22</sub>O<sub>3</sub>Si



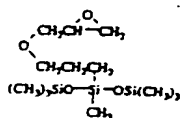
(3- GLYCIDYOXYPROPYL)TRIMETHOXY-SILANE  
3-(2,3-EPOXYPROPOXY)PROPYLTRIMETHOXY-SILANE  
C<sub>9</sub>H<sub>20</sub>O<sub>5</sub>Si



(3-GLYCIDYOXYPROPYL)METHYLDIMETHOXY-SILANE  
C<sub>9</sub>H<sub>20</sub>O<sub>4</sub>Si



(3-GLYCIDYOXYPROPYL)METHYLDIETHOXY-SILANE  
C<sub>11</sub>H<sub>24</sub>O<sub>4</sub>Si



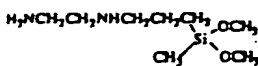
(3-GLYCIDYOXYPROPYL)BIS(TRIMETHYL-SILOXY)METHYLSILANE  
C<sub>13</sub>H<sub>32</sub>O<sub>4</sub>Si<sub>3</sub>



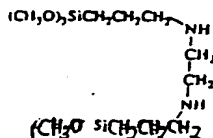
(3-ACRYLOXYPROPYL)TRIMETHOXY-SILANE, 95%  
C<sub>9</sub>H<sub>18</sub>O<sub>5</sub>Si



N-(2-AMINOETHYL)-3-AMINOPROPYLTRIMETHOXY-SILANE  
C<sub>8</sub>H<sub>22</sub>N<sub>2</sub>O<sub>3</sub>Si



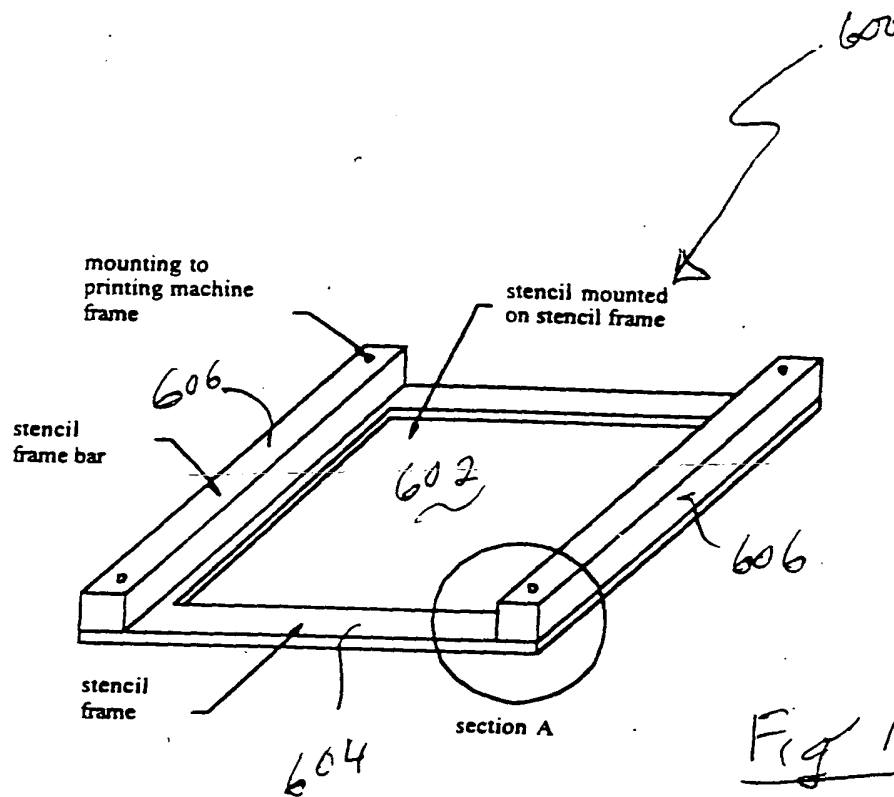
N-(2-AMINOETHYL)-3-AMINOPROPYLMETHYLDIMETHOXY-SILANE  
C<sub>8</sub>H<sub>22</sub>N<sub>2</sub>O<sub>2</sub>Si



BIS[3-TRIMETHOXY-SILYL]PROPYL-ETHYLENEDIAMINE,  
C<sub>14</sub>H<sub>36</sub>N<sub>2</sub>O<sub>6</sub>Si<sub>2</sub>

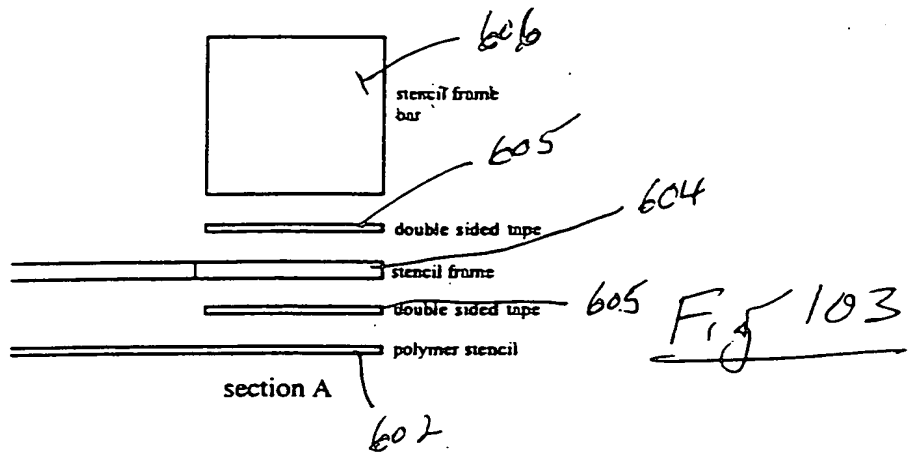
1005495 000000



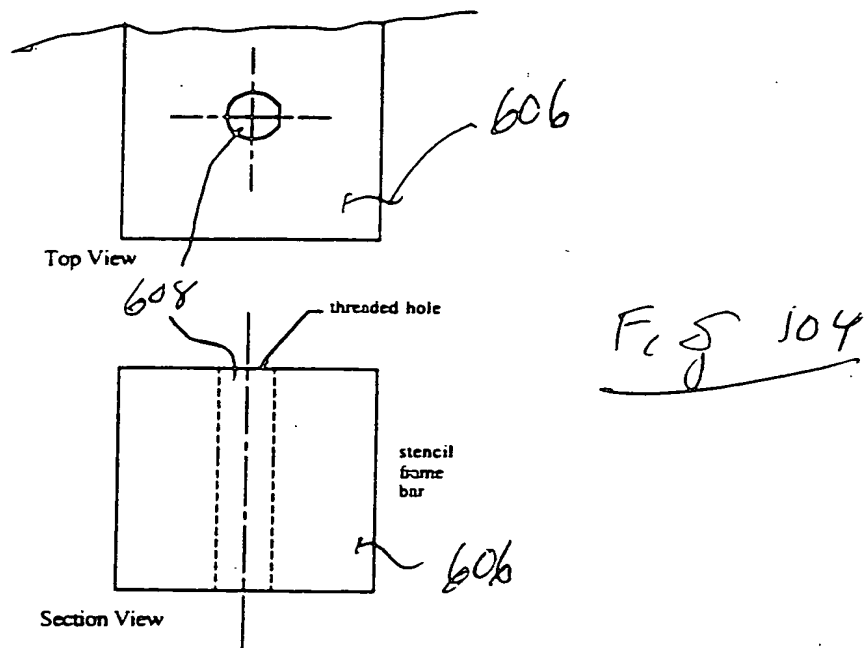


Stencil Frame Layout.

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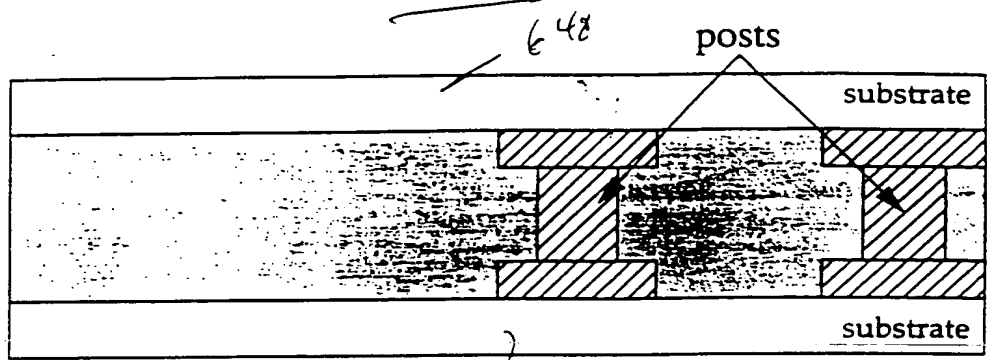
Section View of Stencil Frame Components.



Tapped Hole in Stencil Frame Bar.

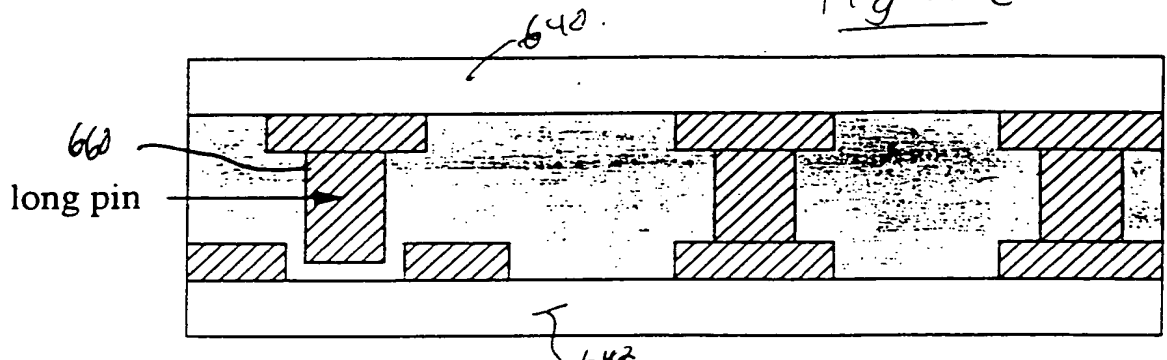
Traditional joining

Fig 105



Alignment and holding using long pin

Fig 106



Alignment and holding using thick pads

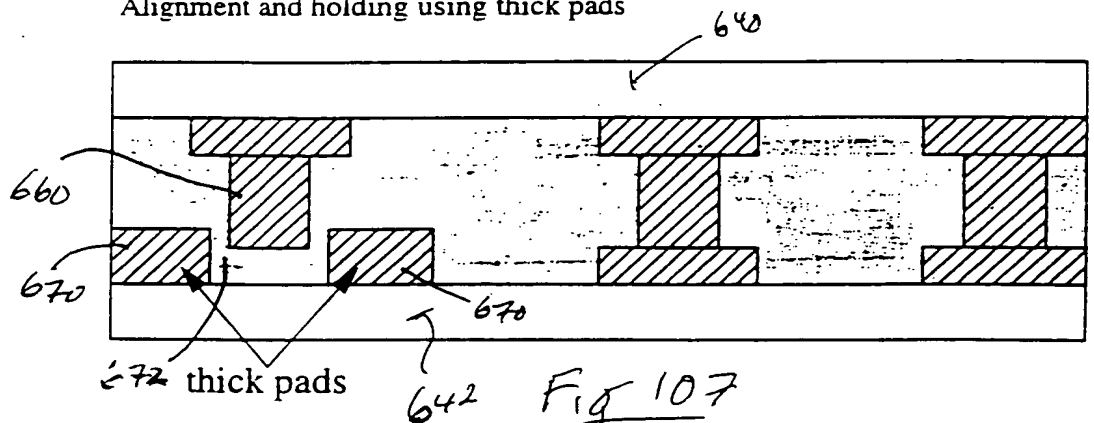


Fig 107

1005495 020402

Build-up process for long pin

Fig 108

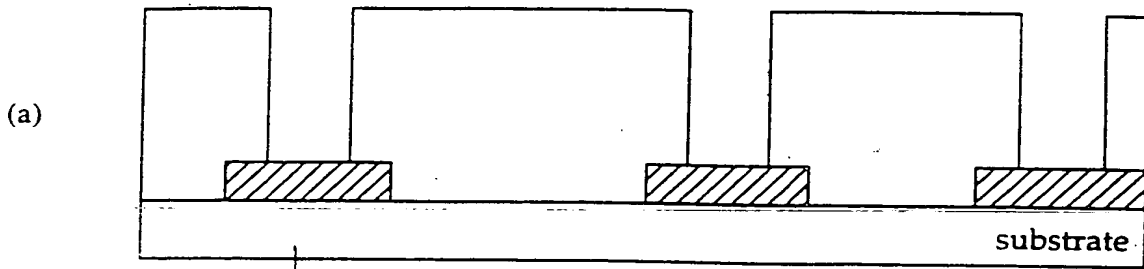


Fig 109

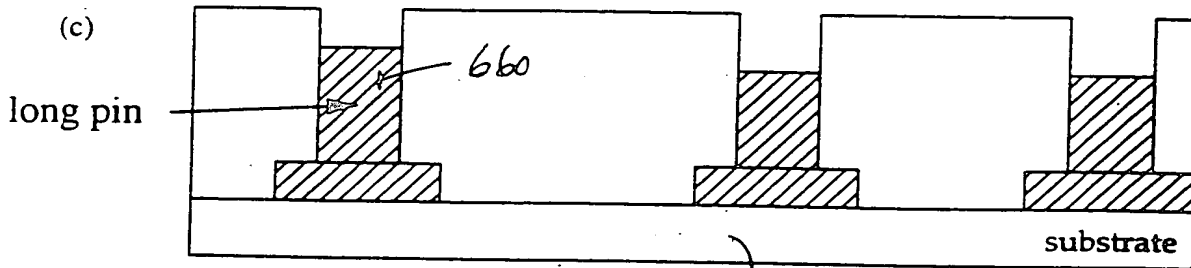
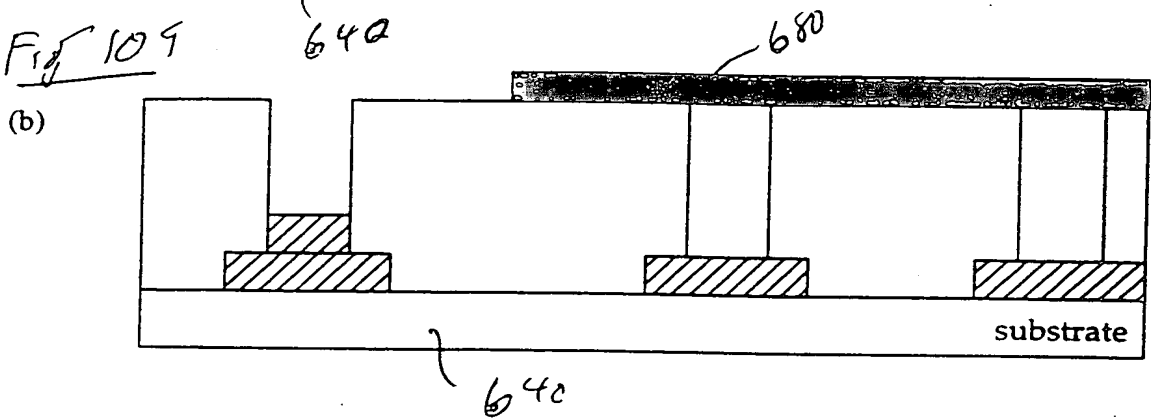


Fig 110

201201-55195001

1056495-020102

Fig 111

Another build-up process for long pin

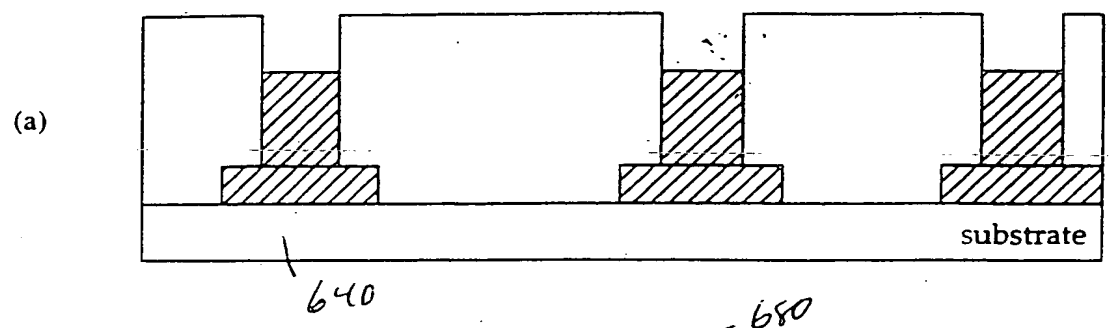


Fig 112

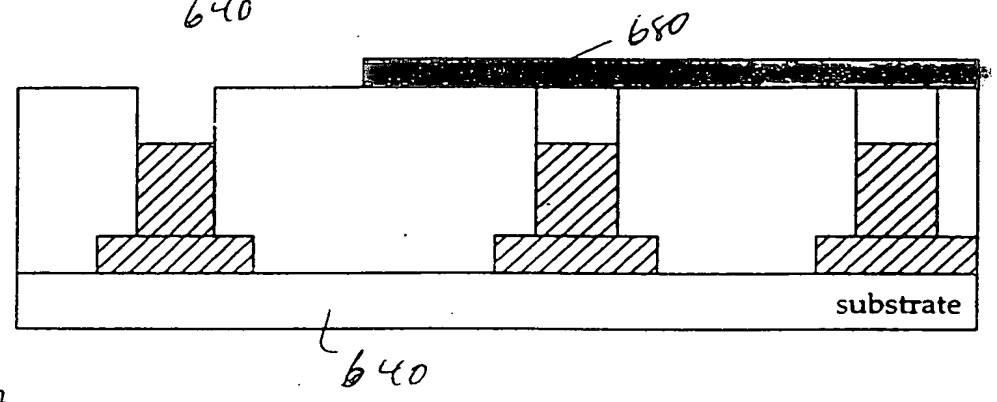
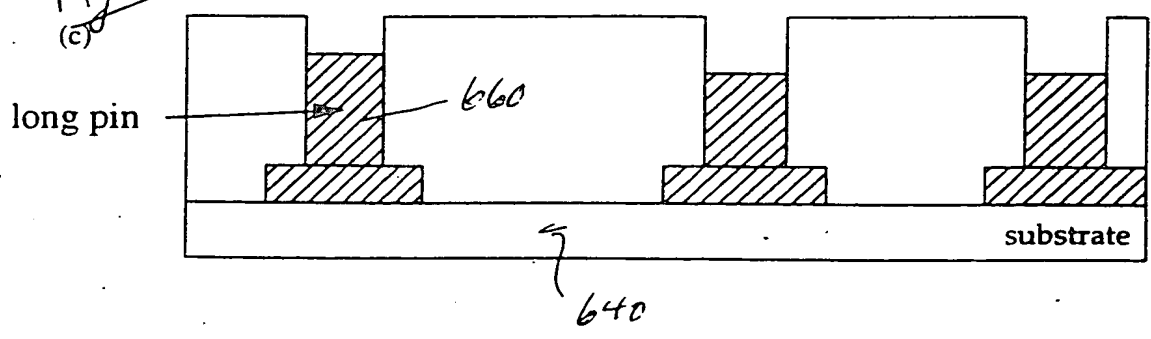
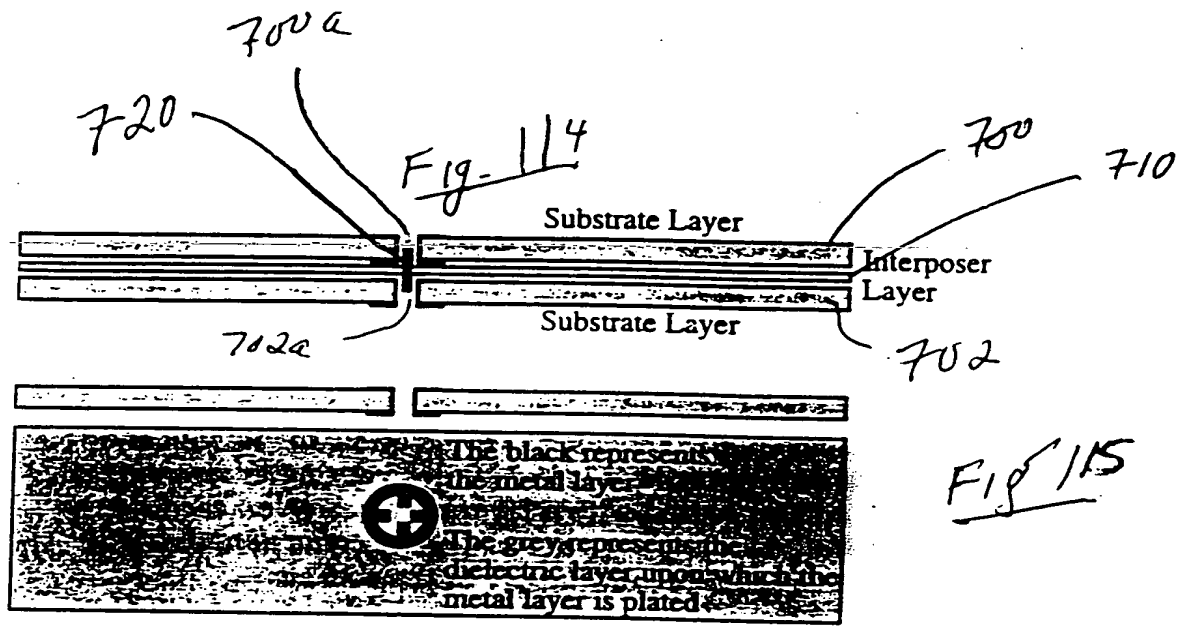


Fig 113

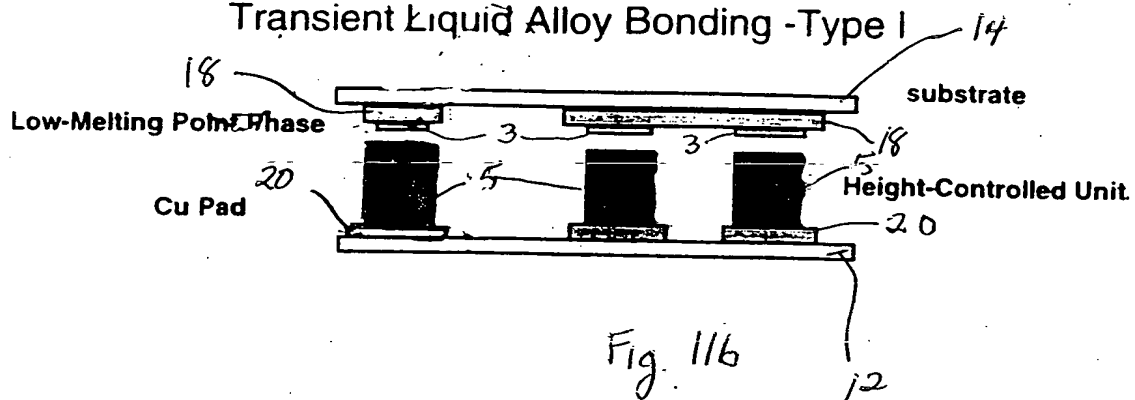


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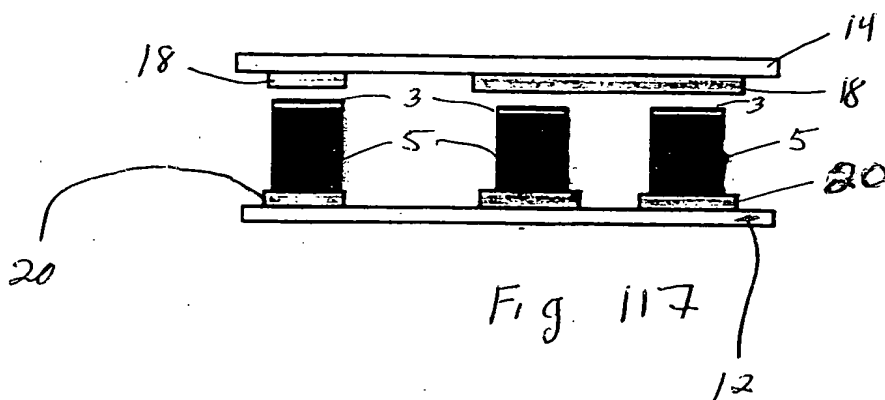
Transient liquid alloy bonding process with separate bonding phases.

### Transient Liquid Alloy Bonding - Type I

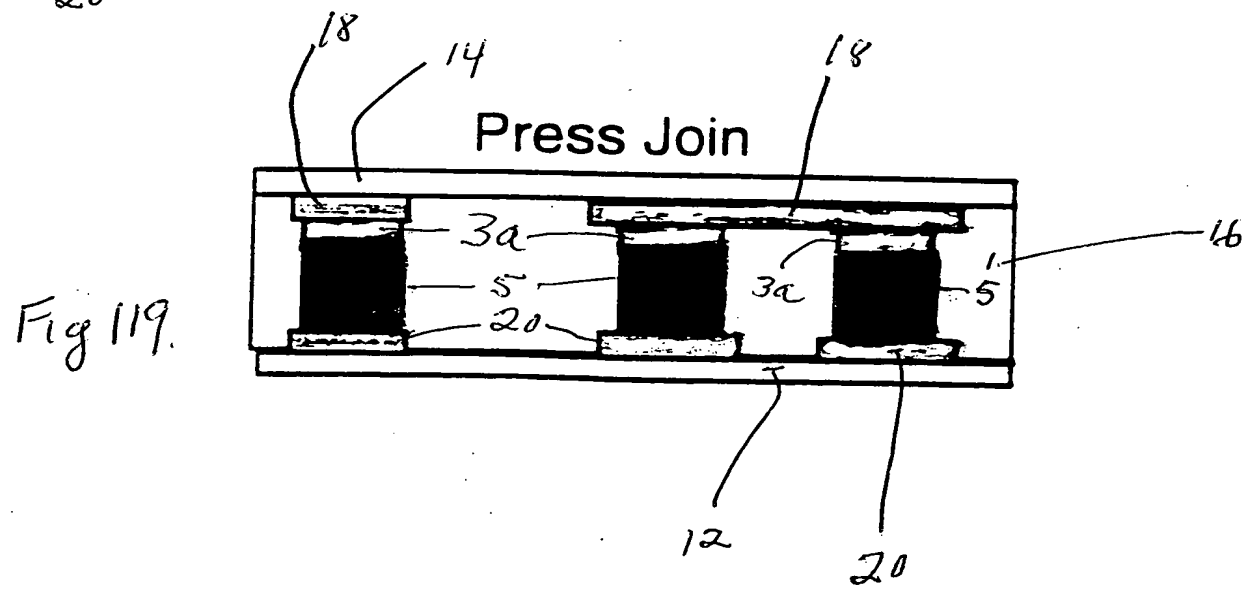
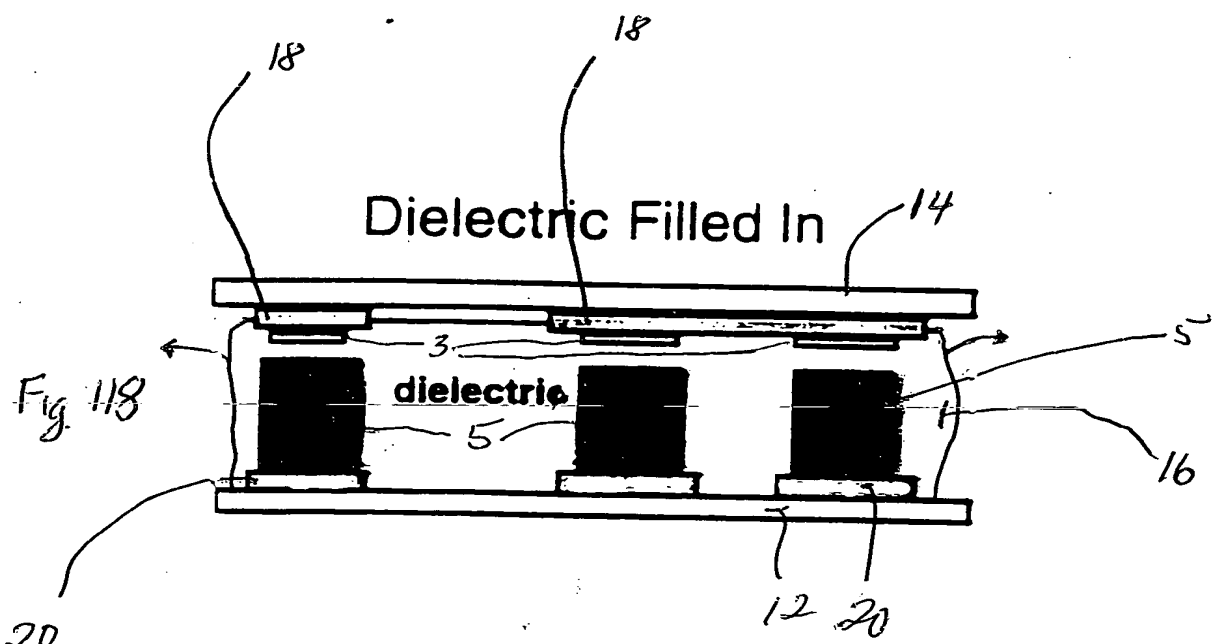


Transient liquid alloy bonding process with one side bonding phases.

### Transient Liquid Alloy Bonding - Type II



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1066495-020103

Fig. 120

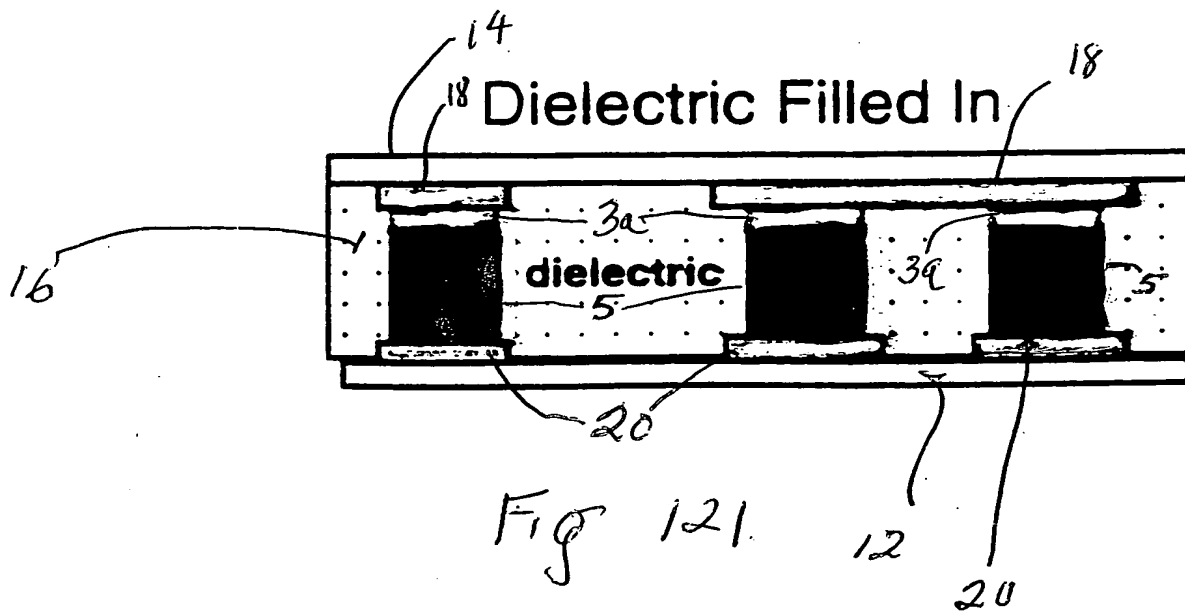
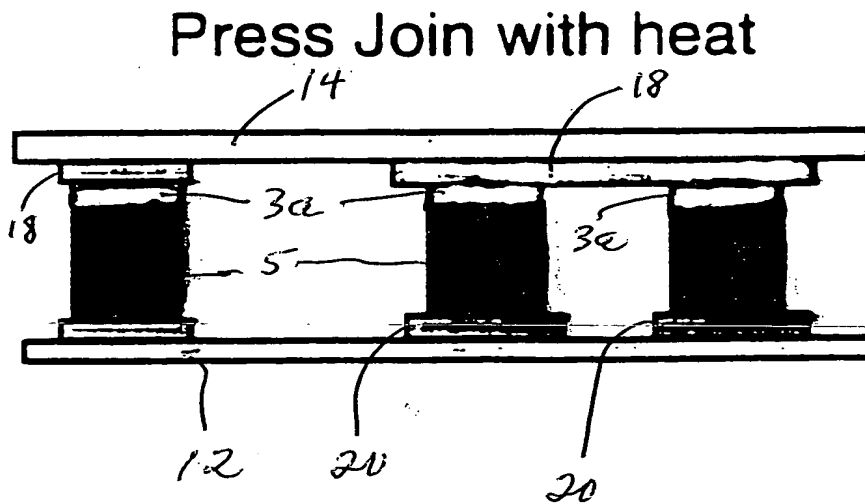


FIG. 122

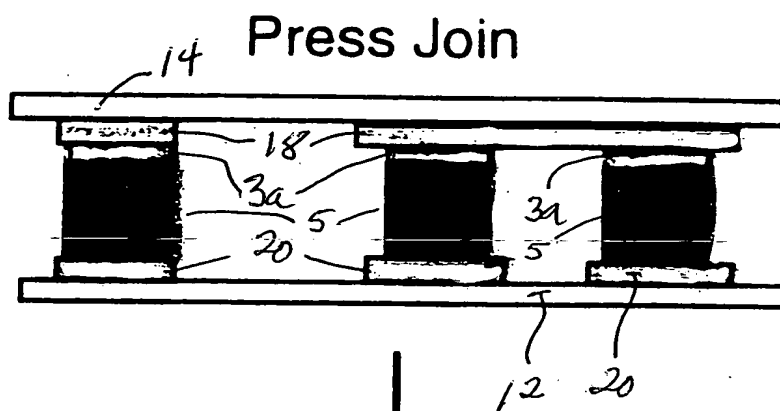


Fig 122.

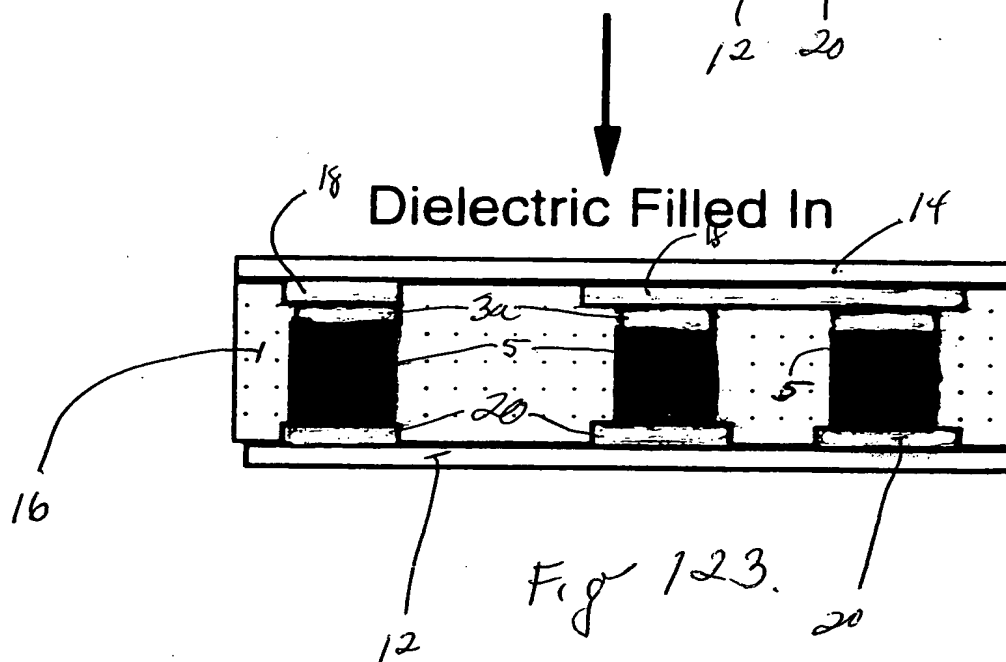


Fig 123.

20250505 100545

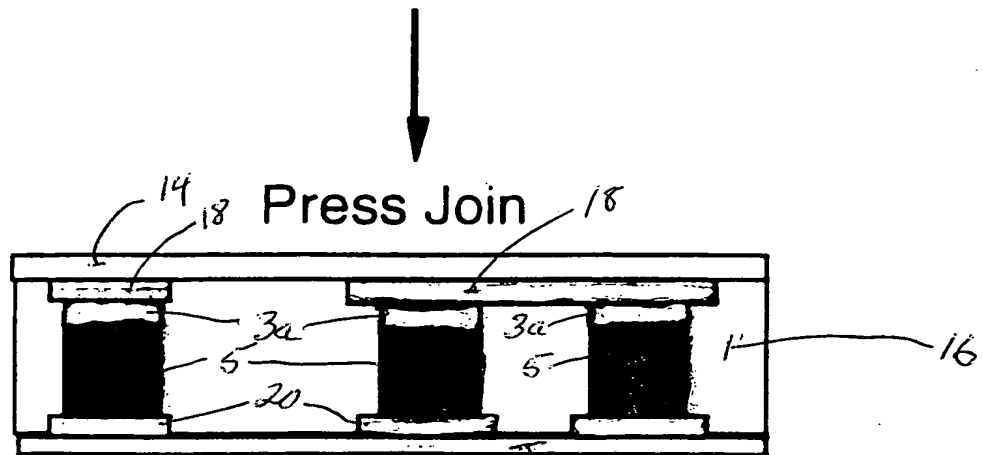
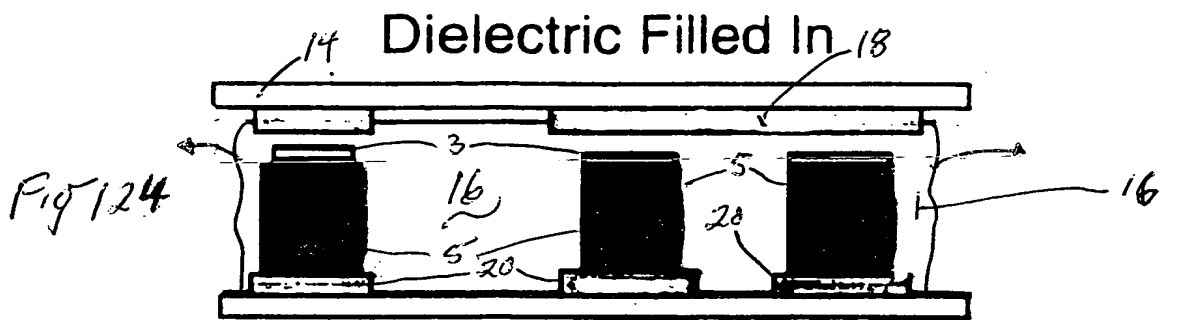


Fig 125

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